MACHINERY

SEPTEMBER, 1914

A MODERN HEAT-TREATMENT PLANT

NEW FEATURES IN DODGE BROS. HEAT-TREATMENT SHOP—CYANIDE HARDENING

BY E. F. LAKE*

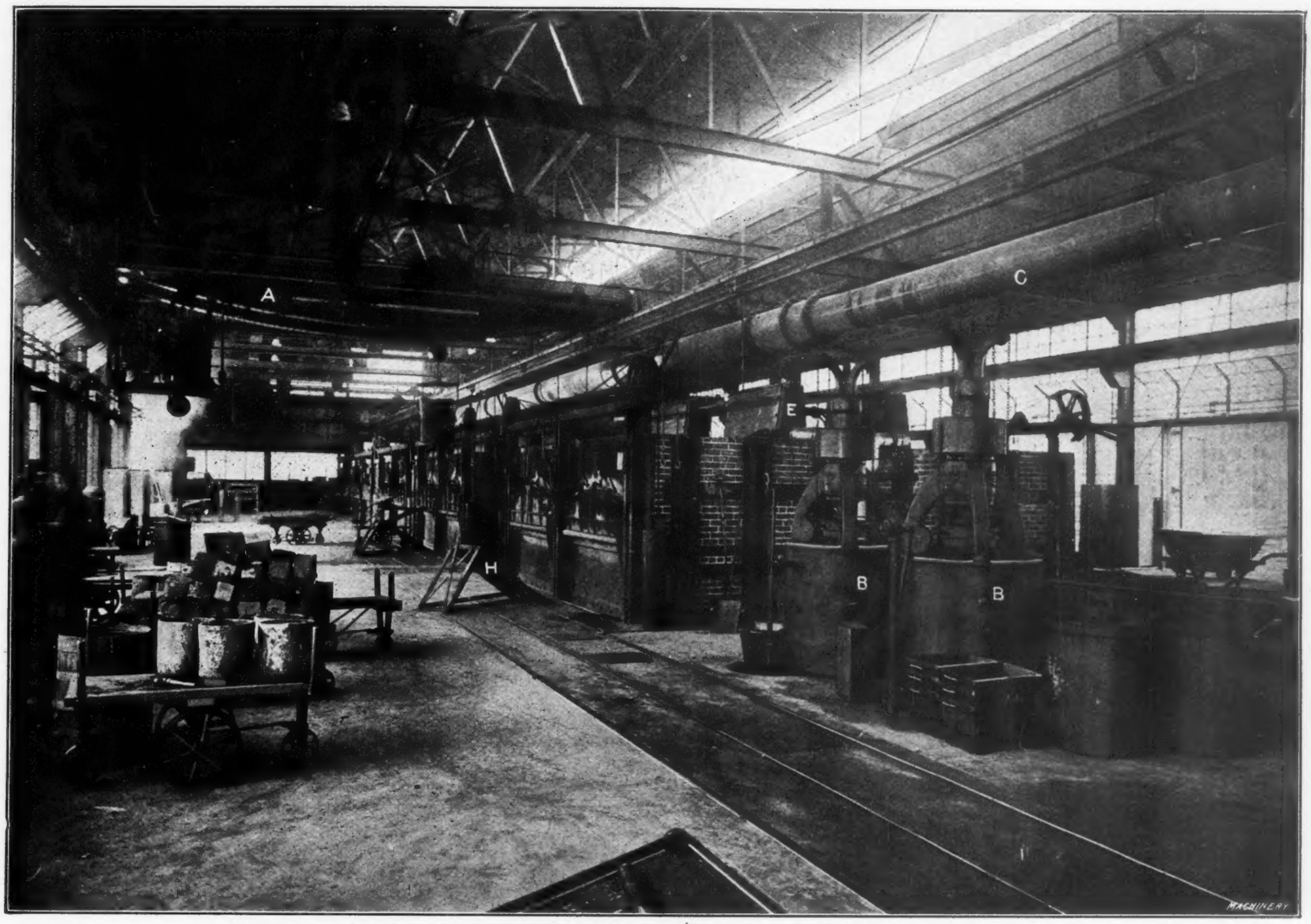

Fig. 1. North Half of Heat-treatment Building recently added to Dodge Bros. Plant, Detroit, Mich.

THE increase in strength, wearing qualities and resistance to fatigue that can be given steel by a proper heat-treatment is fast being recognized by those that manufacture products out of this metal or alloy. Therefore, many improvements are being made in hardening rooms and new apparatus is continually being devised and installed to insure certainty of results.

The ordinary machine steels, which do not contain enough carbon to be made hard enough to resist filing, will show an increase of from 10 to 30 per cent in their tensile strength, compressive strength and elastic limit when heated to a temperature a little above their highest transformation point and then cooled suddenly. In the higher carbon steels this increase is raised to 50 and 60 per cent, while many of the special alloys are given two and three times the strength they have when they leave the rolls or when in the annealed state. The resistance to fatigue can be increased in greater proportions by a correct heat-treatment. Other physical properties can also be made better able to resist the strains or stresses to which a given part may be subjected.

Thus, machine parts can be designed considerably lighter when they are to be heat-treated, and the saving in material will often more than pay for the cost of heat-treating. These conditions have even started an agitation in favor of heat-treating structural steel, while heat-treating all of the steel that goes into bridges has been advocated for some time. In the moving parts of machinery, the saving in the cost of power to move them should be added to the saving in the pounds of steel used, to show the real economy of heat-treatment. Other things should also be considered; for instance, less material in such parts as carry or support these heat-treated parts; a reduction in the size of surfaces to be machined; smaller foundations; lower freight bills; smaller, and thus cheaper, hoisting and conveying apparatus to handle such parts when machining, erecting or shipping them; less power to drive these, etc. In order to give the maximum physical properties to their steel parts and take advantage of those factors which would effect a saving in the cost of production, Dodge Bros., Detroit, Mich., recently completed a building, 70 feet wide and 400 feet long that will be devoted exclusively to the heat-treatment of steel. They have just discontinued manufacturing parts for the Ford automobile in order to build a car of their own design.

In Fig. 1 is shown the interior of about one-half of this building. The side walls are composed of structural steel and "Fenestra" sash; this makes them nearly all glass and admits the maximum amount of light. The roof is of steel framework and fire-proof roofing. Throughout the entire length of the building, the central part of the roof is raised some six feet to provide for windows that will let out the smoke, steam, gases, etc., and admit more light. The apparatus and methods that have been devised during the past few years for the accurate heat-treatment of steel have done away with the necessity of darkening hardening rooms, so the color of heated steels could be properly judged. Thus

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Fig. 2. Pair of Rockwell Furnaces, which pre-heat the Air before mixing it with the Fuel Oil for Combustion

the modern heat-treating rooms are made as light as possible.

The furnaces and other heat-treating apparatus are located through the center of the shop, lengthwise. (See the plan view, Fig. 5.) The battery of furnaces shown in Fig. 1 is oil-fired and is used for hardening, annealing and carbonizing. These twenty furnaces are of the under-fire oven type and were built in pairs and placed back to back by the W. S. Rockwell Co., New York. They pre-heat the air just before it enters the burners, to economize on the amount of fuel oil used. In the concrete floor in front of the furnaces, on both sides of the shop, a standard gage track runs the entire length of the building. Its special cars will be described later. Two 2-ton, electric traveling cranes, like that shown at *A*, Fig. 1, are operated on both sides of the shop in front of the furnaces. These were built by Pawling & Harnischfeger, Milwaukee, Wis. The Gleason Works, Rochester, N. Y., furnished the two special gear-quenching machines shown at *B*.

Fig. 3. Blowers for forcing Compressed Air to the Furnace Burners

In Fig. 2 will be seen a single pair of this battery of twenty furnaces. The piping, burners, etc., are all located at the back of the furnaces and this leaves the front clear for the work of the furnace operators. Three motor-driven blowers (made by the B. F. Sturtevant Co., Boston, Mass.,) shown in Fig. 3 are used to furnish all the air required in the shop. The air is forced through pipe *C*, Figs. 1 and 2, which runs the full length of the center of the shop. (Symbols signify the same thing in all views.)

The alley-way between the backs of these furnaces is shown in Fig. 4. The sole duty of one man consists of keeping the furnaces operating at the correct temperatures and this will keep him in this alley-way most of the time. The temperature there is not uncomfortable, however, as the furnaces have been designed and built so as to retain the heat inside. The shop can be heated in a much cheaper way. To preheat the air before it goes to the burners, it is drawn from main pipe *C* through pipe *D* and into a pipe coil inside of box *E*, Figs. 2 and 4. The exhaust or spent gases from the furnace are sent through box *E* and around the pipe coil. This heats the compressed air while it is passing through the coil and it then goes through pipe *F* and into the burners at *G*. There it is mixed with the fuel oil in the proper proportions to perfect combustion.

One of the hardening jobs which is done in this battery of furnaces is shown in Fig. 6. Automobile driving shafts have been charged into the furnace. This is done by inserting into the oven the lower end of an inclined plane like those shown at *H* in Figs. 1 and 2. The supporting legs rest on the outer edge of quenching tank *I*. Then the traveling crane brings a load of the shafts to the furnace in a special rack and dumps them on the inclined plane so they will roll back into the furnace. When heated to the hardening temperature, the shafts are pulled out with long rods that have a hooked end. Fig. 6 shows some as they are rolling down the sheet-steel hearth *J* to drop onto a jointed rack in the oil in tank *I* and thus become quenched. Fig. 7 shows how the traveling crane lifts one side of this jointed rack to raise the drive shafts out of the oil and dump them onto the trucks by which they are taken away.

The quenching tank cars are one of the decided novelties of this department. Several are used on both sides of the shop and they are wheeled to any furnace desired. Standing oil would soon get too hot to quench the steel enough to give the required hardness; therefore, the valve in pipe *K* is turned on when the work is being quenched and a two-inch stream of cold oil is kept flowing into the tank. The oil, which is heated by the red-hot steel, passes out of overflow pipe *L*, through the hole in the floor and into a pipe that conducts it to an underground tank. This underground pipe is made very large so there will be no danger of its clogging, which would necessitate tearing up the floor. Each furnace throughout the 400-foot length of the shop is provided with a similar inlet pipe and floor hole connection to the pipe that carries away the overflow.

From the underground tank the oil is pumped to upright tanks close to the outside of the building. One of these can be seen through the crack of the door at *N* in Fig. 8. From these tanks the oil flows by gravity to the tank cars. One of the motor-driven pumps shown at *M* is used for pumping the oil, and the other is used for pumping the water that is used for quenching steels. They are located next to the side wall, near the center of the heat-treating building and give a good circulation to all of the quenching fluids. At the extreme left of this same view a man is at work testing hardened pieces with the scleroscope.

The equipment for hardening and tempering forging dies is another decided novelty. This is shown by Figs. 9 and 10. Four runways, filled with three-inch malleable iron balls, ex-

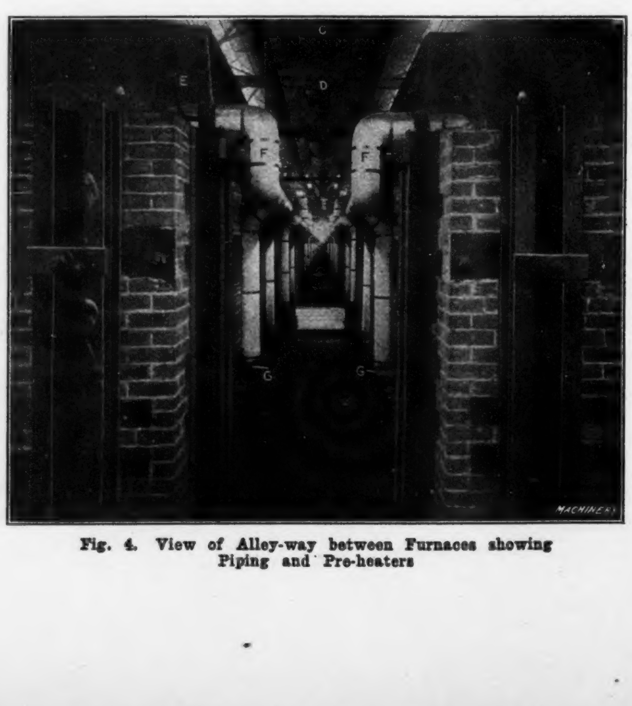

Fig. 4. View of Alley-way between Furnaces showing Piping and Pre-heaters

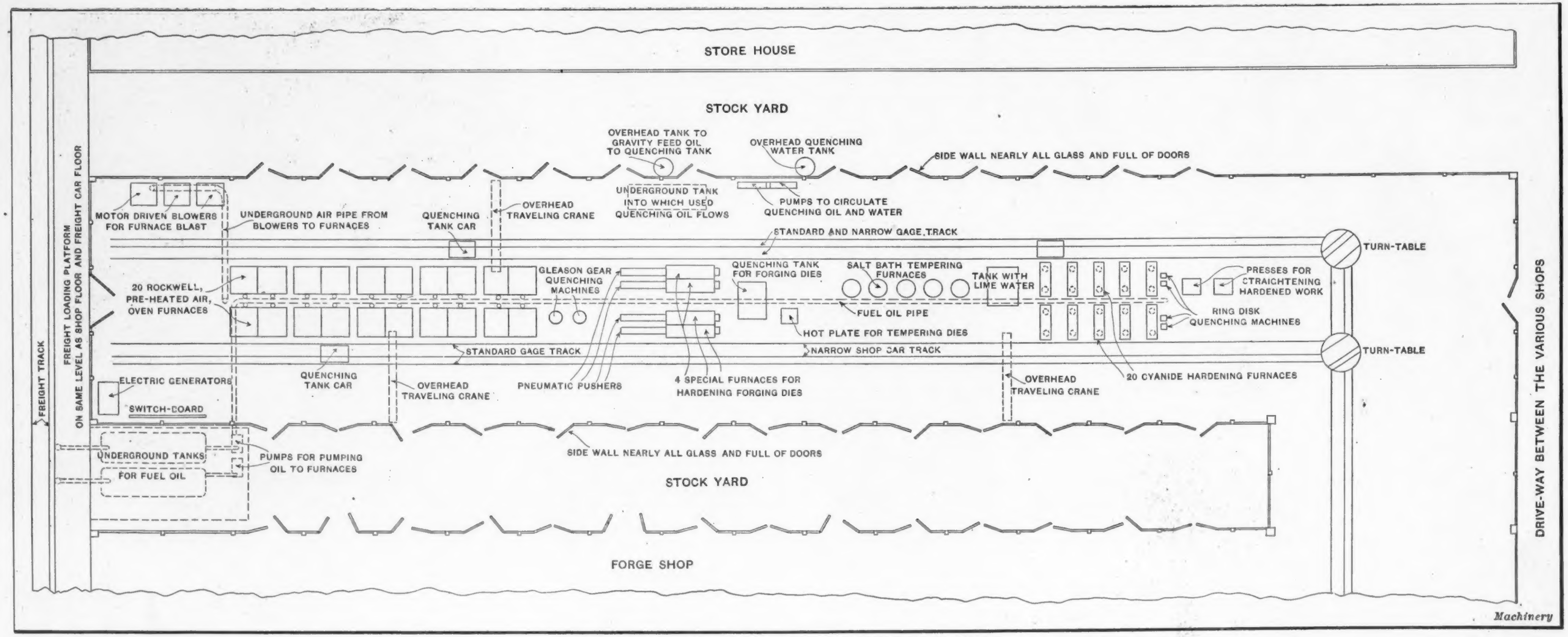

Fig. 5. Floor Plan of Dodge Bros. Heat-treatment Building

tend throughout the length of the oven floor of the heating furnaces. Castings, that fit over the balls in two of these runways and that are the correct size to carry one of the forging dies, are placed in position in the end of the furnace shown in Fig. 9. When the cold die is placed on this casting, as shown at *O*, one of the pneumatic pushers *P* is brought into play and the castings act as a cart to carry the die into the furnace. When the furnace is full, the ram has to move a whole row of dies to get the last one in, but with the casting cart rolling over balls this is easily done. It then pushes the first die out of the other end ready to quench. Each furnace is double tracked and heats two rows of dies at once.

At the end of the furnace shown in Fig. 10 the hot dies come out on the extension of the runway marked *Q*. Their faces are turned downward so a traveling crane, with tongs similar to ice tongs, can pick them up and lower them into the quenching tank, as shown at *R*. If a die was quenched like this, in standing water, the steam would be liable to form pockets in the impression cut for the forging and thus leave soft spots; therefore, each die is held a few inches above the water level and a two-inch stream of cold water is squirted upward to cover the face of the die and quench it uniformly all over. This stream continually forces away the water that has been heated and keeps the cold water flowing over the face of the die. The heated water passes through an overflow pipe to an underground pipe, the same as the oil does in the quenching tanks shown in Figs. 6 and 7.

The hot plate shown at *T* is used for drawing the temper. This is an iron casting, about two inches thick, that has been planed smooth on the top surface. It is kept red hot by burning fuel oil underneath the plate. The dies are moved around on this hot plate until they show the color that indicates the correct drawing temperature. Then they are cooled and sent to the forge shop.

A battery of twenty cyanide furnaces is shown in Figs. 11 and 12. These are located in the opposite end of the building from that illustrated by Fig. 1. In front of the first pair of cyanide furnaces in Fig. 11, two special machines are shown, which suddenly cool or quench the work as fast as it can be heated and removed from the furnace. They are used for hardening the steel ring disks shown at *U*. These alternate with brass disks in a multiple disk clutch on the engine of the automobile. They resist wear for a much longer time when they are correctly hardened.

Each of these machines consists of three iron castings that are located one above another and have flat machined surfaces. These castings are about 2½ inches thick and are hollow in the center so water can be forced through to cool them. The upper and lower castings are kept about 3½ inches apart by bolts and are held stationary. Compressed air moves the middle casting up and down against the others.

One man keeps all of the twenty furnaces operating at the correct temperature, with the aid of pyrometers and the burner valves. Then the man at the furnace only puts the

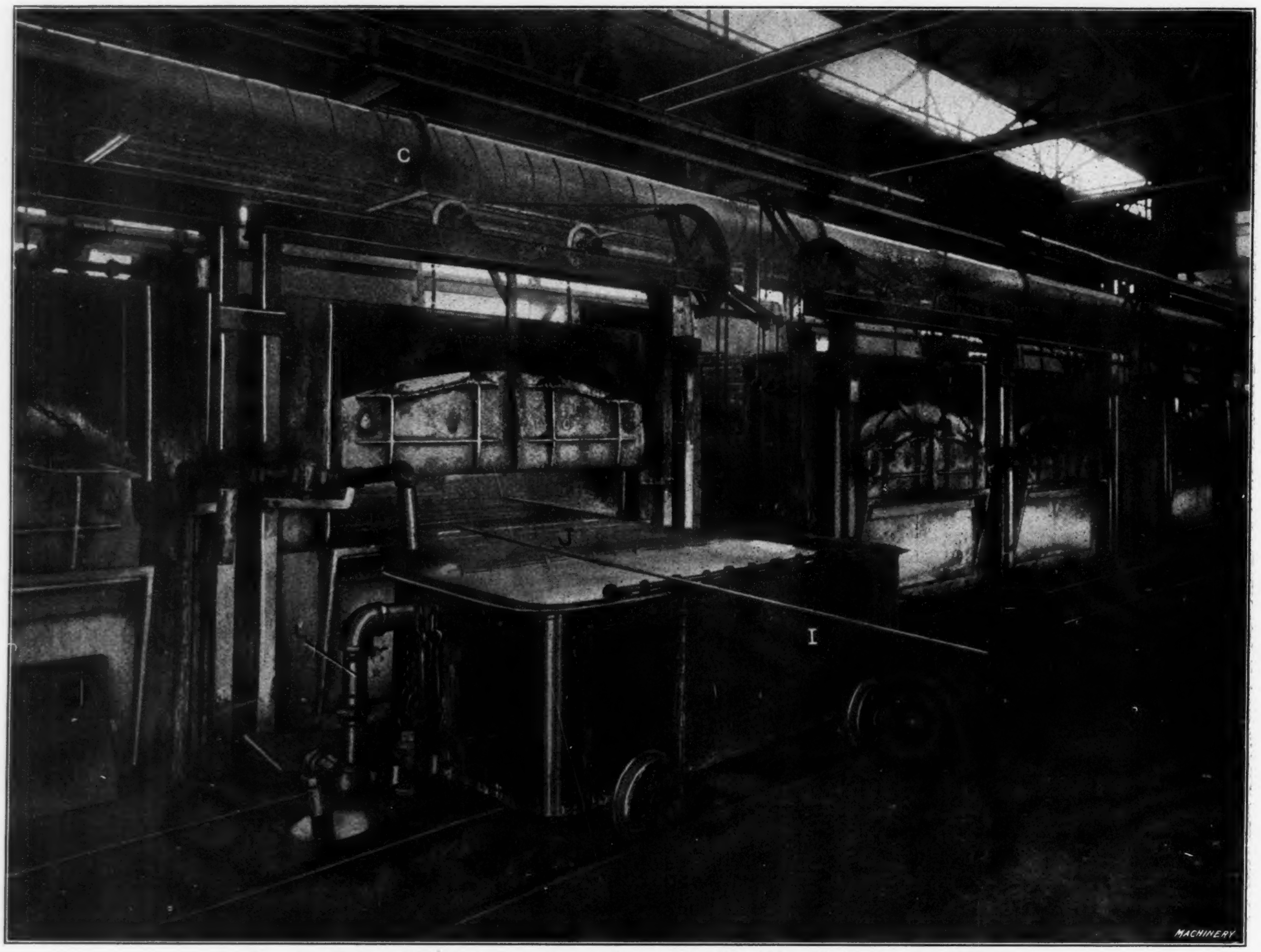

Fig. 6. Oil Quenching Tank ready for receiving Automobile Drive Shafts from the Furnace

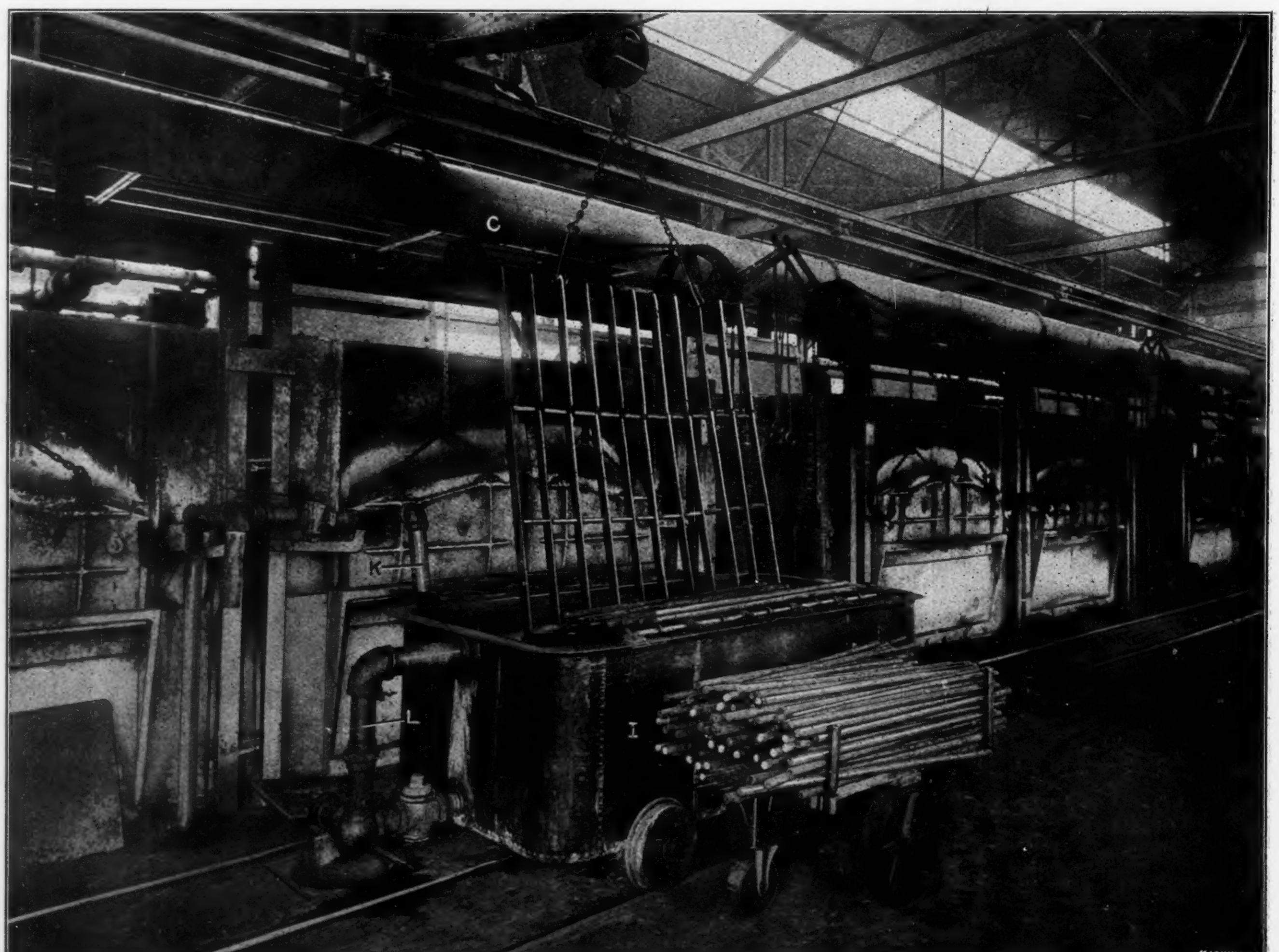

Fig. 7. Dumping the Drive Shafts from an Oil Quenching Tank into Truck

disks into the molten cyanide and removes them when they have reached the hardening temperature. He removes them one at a time and passes them to a man stationed at the machine. The machine man puts this red-hot disk *U* between the upper and middle castings at *W* and in so doing, knocks out the disk that was formerly cooled. He then steps on pedal lever *X* and causes the air to press the middle and upper castings together with the disk between them. The water flowing through the center of these iron castings keeps them cool enough to quench the red-hot ring disks quickly, as they are only 1/8 inch thick. Thus they are hardened and at the same time kept from warping. The next disk is inserted between the lower and middle castings at *Y* and foot lever *Z* is stepped on to press these together and squeeze the disk; at the same time, this releases the disk at *W* so it can be pushed out.

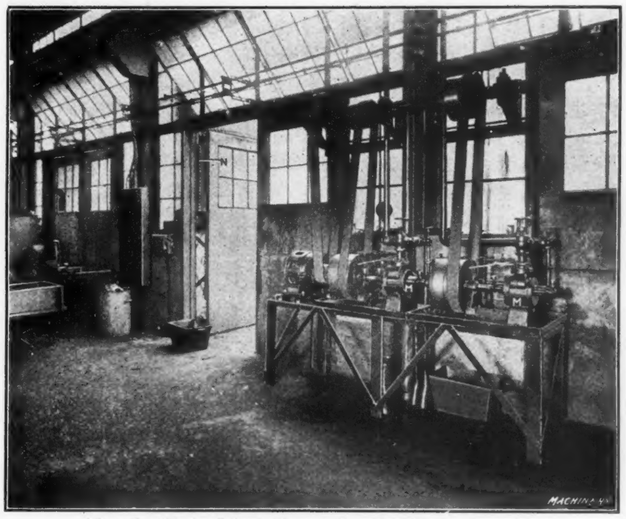

Fig. 8. Motor-driven Pumps for circulating Quenching Oil and Water

By thus alternating the pressure on the middle casting, so it will first press against the upper and next against the lower casting, the disks can be quenched as fast as they come from the furnace and the furnace heats them as fast as the machine man inserts them between the castings and depresses the pedal levers. This work is done much faster than it takes to describe it and no skilled labor is used. With such apparatus unskilled labor is today doing hardening and tempering at more accurate temperatures and with greater uniformity than was obtained by skilled labor only ten years ago. Other ways of saving on the cost of production have also been perfected and we are now enabled to heat-treat parts with economy that formerly would add much to the cost of the finished product.

The potassium cyanide used in these furnaces is a salt that will keep molten when heated to any of the temperatures that are used for hardening steel. As the name implies, it is composed of equal parts of potassium, carbon and nitrogen; its chemical symbol being KCN. The carbon in this composition has a tendency to carbonize the steel being heated in the bath and this overcomes any tendency toward a decarbonization. If machine steel is immersed in a bath of cyanide and kept at a hardening temperature for a certain length of time, it can be given a carbon content of from 0.60 to 0.80 per cent for the depth of a few thousandths inch. For various reasons, however, it is not as good as other materials for the real carbonizing process.

In oven and muffle furnaces every effort is made to keep the atmosphere either neutral or reducing; that is, to allow no more oxygen to enter than will be used for combustion. When the furnace doors are continually opened, to insert and remove the work, this is a very difficult thing to do, as air is likely to rush in and carry with it an excess of oxygen. This excess oxygen makes the atmosphere oxidizing and it unites with the iron and raises a scale on the steel being heated. This sets four times as much nitrogen free to combine with the carbon in the steel and form the gas methane, which escapes when the metal undergoes changes in its grain structure as its temperature rises. Thus, when steel is heated to the hardening temperatures in such furnaces, a slight decarbonization of all the exposed surfaces often takes place. Frequently this action is not uniform and decarbonized spots are produced. The higher the temperature, the more easily can carbon be drawn out or made to flow into the steel. To overcome such chemical changes, steels have been heated for hardening in a molten cyanide bath, as then the air is kept away from the steel and a slight carbonizing effect is produced instead of a decarbonizing one.

As cyanide of potassium is very poisonous and also the fumes which arise from it when molten, the furnaces must be covered and other precautions taken. Each pair of furnaces, shown in Figs. 11 and 12, is covered with a hood to gather the poisonous fumes and convey them to the outer atmosphere, through pipes extending through the roof. In addition to this, sheet metal shields are located in front of the furnace openings shown at *V* to carry away from the workmen any fumes that might come through these openings. (These shields were removed for photographing). The workmen wear gloves while using the furnaces, and, in some cases, face masks to protect any exposed parts of the body.

As to the poisonous nature of cyanide of potassium, two grains might be enough to kill a man and in other cases it might require fifty grains. A solution of one ounce of cyanide to four ounces of water is one of the best things for cleaning rust from polished steel surfaces or the oxide from other metals. In one case a jeweler had a barrel filled with this solution and standing in the basement for cleaning silverware and other metals. A scrub woman, thinking it was potable water, drank a glassful and dropped dead beside the barrel. It almost instantly paralyzes the flesh tissues of the body and thus stops their action

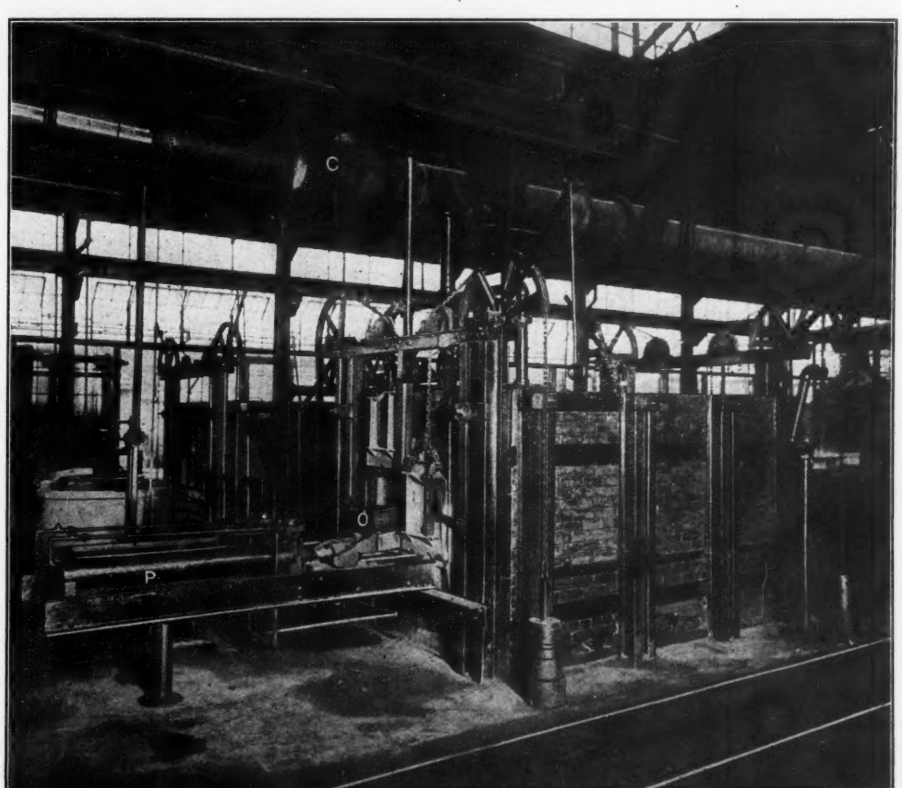

Fig. 9. Intake End of Special Furnace for hardening Forging Dies

and causes death. It will not penetrate the skin unless submitted to its action for quite a time but it is liable to penetrate raw sores. It dissolves very readily in water and if one were perspiring, the dry salt would dissolve in the perspiration and more quickly pass through the skin. The fumes arising from the molten cyanide are a cyanogen gas, which is extremely poisonous, and this paralyzes the lungs in the same manner that drinking a solution, or swallowing the dry salt, would paralyze the tongue, throat and stomach.

After rust and scale have been cut loose and removed by a cyanide solution, steel surfaces can be polished by a hard rubbing with cyanide soap. To make this, stir potassium cyanide in water until no more will dissolve; then add enough precipitate chalk to make a creamy paste. To this paste, add Castile soap shavings until it is quite stiff. These should be thoroughly mixed, which is best done with a mortar.

The poisonous nature of cyanide has caused searches to be made for materials that will give as good results and not have any poisonous effect. Other salts and combinations of salts are being used with the claim that the results are the same. None of them contain as much carbon as cyanide of potassium and hence could not have as great a carbonizing effect on the steel. Steels that were high enough in carbon could be used, however, and if they prevented a decarbonization the same results would be attained. When steel is immersed in a salt bath and then heated, oxygen cannot get to it and this cause of decarbonization would be overcome. Some of the chlorides are combined in a way to give them melting temperatures which make them useful for heating steels to any of the hardening temperatures. The nitrate, carbonate and fluoride salts might also be made into combinations that would keep molten at the desired temperatures and not be poisonous or have injurious effects on the steel.

The nitrogen content of the cyanide of potassium is liable to have a bad effect on the steel and thus be a detriment to its use. If any nitrogen were absorbed by the steel, the elongation and contraction would rapidly diminish with each increase in the percentage of nitrogen and the ductility would be reduced. When the pores of the steel are opened, as its temperature reaches the transformation point at which it is hardened, the carbon will enter the steel and is liable to carry some nitrogen with it. The best carbonizing compounds are free from nitrogen. Investigations have shown that nitrogen causes brittleness in the same manner as does phosphorus but more intensely. On steel specification reads "The sum of the percentage of phosphorus, plus 5 times the percentage of nitrogen, should not exceed 0.060 per cent."

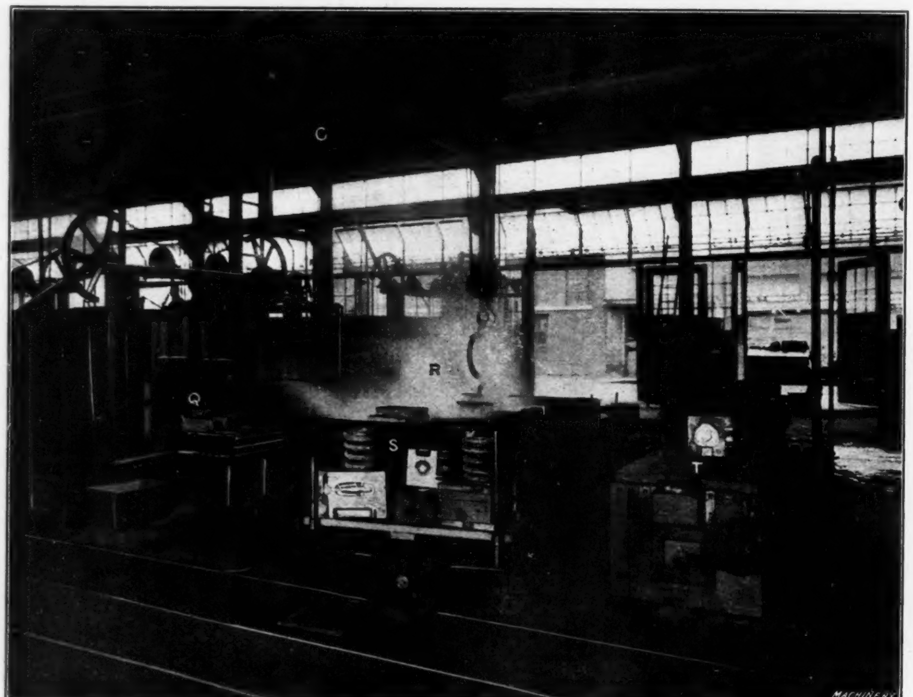

Fig. 10. View showing End where Dies are removed from Furnace; also Quenching Tank and Tempering Plate

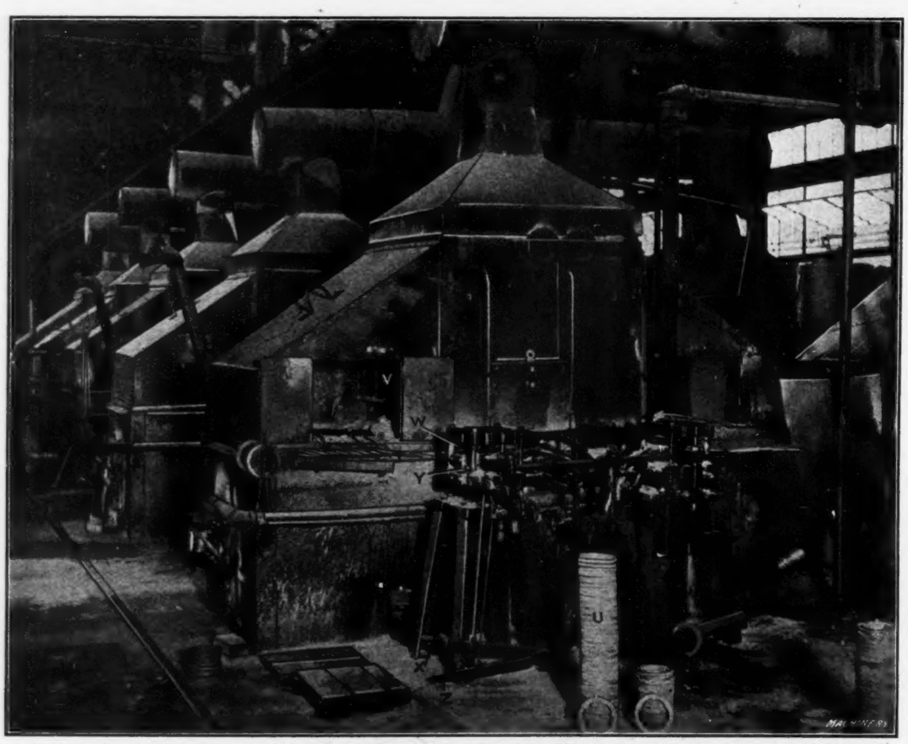

Fig. 11. Battery of Cyanide Furnaces—Special Quenching Machines for Clutch Rings in Foreground

To illustrate this, some watch springs were heated for hardening in cyanide of potassium. When used, it was found that the main springs wore well but the hair springs broke quickly. The main spring is subjected to a steady tension but the hair spring is subjected to alternating vibrations by the oscillations of the balance wheel. Thus any brittleness would soon cause the hair spring to rupture but might have but little effect on the main spring. When the same hair springs were heated to the hardening temperature in molten glass, they did not break and this might indicate that it was the nitrogen in the cyanide which caused the brittleness.

Steel is sometimes immersed in molten cyanide and then dipped in water to produce certain colors. Other processes are now used, however, which produce richer colors in a greater variety of shades and at less cost. To keep the steel pieces from hardening, when being colored, it is necessary to melt the cyanide in pots made from low-carbon steel, as cast-iron pots increase their hardness. The cyanide acts as a conductor for carbon in much the same manner as a copper wire does for electricity; thus the carbon flows from the iron pot into the steel being heated. Sometimes the work is made

harder if it is heated in the cyanide the first time it is melted down in a new steel pot; therefore, the cyanide should be melted down once before it is used for coloring.

At the end of the cyanide furnaces shown in Fig. 12 is a stationary tank of lime water in which some of the work is quenched. At the side of the first furnace is located another of the quenching tank cars. On the floor is shown a tray loaded with bevel differential gears and having a long rod for a handle. This is lowered into the cyanide bath to heat the gears, then lifted out and lowered in the quenching tank, and when cool the gears are dumped into boxes to take to the tempering furnaces. Other parts that were being hardened are shown in the metal boxes beside the tray of gears.

Fig. 13 shows four salt bath furnaces that are used for tempering the smaller pieces. The salt is held in iron pots that are heated with fuel oil the same as the bigger furnaces. As the drawing temperatures seldom run above 1000 degrees F., sodium nitrate and potassium nitrate can be used. These do not corrode the pots as easily as the chloride salts and hence the pots last a long time. There is nothing poisonous about them and there is nothing in them that is injurious to steel. The work sinks in the bath and it is easier

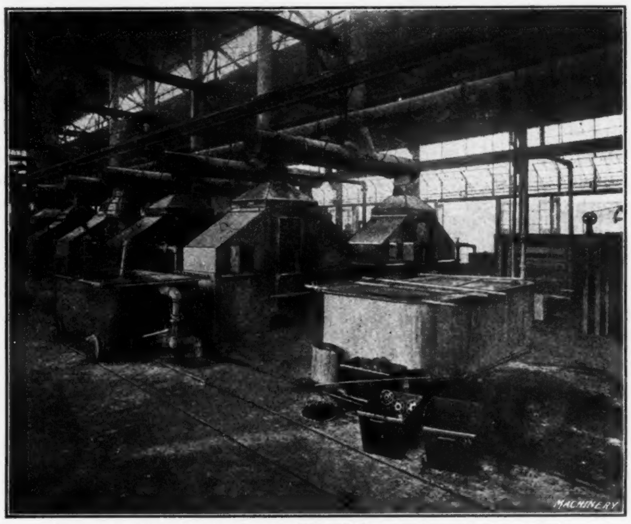

Fig. 12. Cyanide Furnace, Quenching Tank and Car Tank with Flowing Oil

to handle it than when a lead bath is used. If one should hold one's head directly over the pot it would cause a feeling of sickness in the stomach, but this position is not necessary when a rod handle is put on the tray that holds the work. This is the only disagreeable feature of this bath.

An electric generator with a very complete switchboard is located in one corner of the building. This makes the heat-treatment shop a complete unit in itself, as it is not dependent on any other part of the plant for power, light, heat, or anything else. Thus, work can be done there when all the rest of the plant is shut down and no power, heat, etc., would be wasted if it were shut down and all the rest of the plant were working.

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CARRYING OUT THE ORDERS OF THE BOSS

BY CON WISE

There is a widely prevalent idea that as soon as a man goes into business for himself he becomes independent. That this is not so was brought to our attention a few days ago by a neighboring machine tool builder. He was complaining that he was unable to get drawings made to suit him. It was some matter of center lines or style of lettering or some minor thing like that, but one which was a constant source of error in the shop. Come to think of it, the special bone of contention was about using 5ft. 6" or 5' 6", but that is not the point. Here is a case of an intelligent, able-bodied, responsible, profitable concern that pays its bills (including payroll) on time, but that cannot issue an order to its own drafting-room with any confidence that it will be obeyed.

A similar state occurs in many shops, not alone in the drafting-room but in the tool-room. Why is it endured? Simply because the owner knows that if he enforces his regulations his men will quit before very long and go where they can do as they please, and that he cannot get any better conditions by hiring new men, unless he begins all over with entirely green ones and trains them his way. The matter comes about through the assumption of professional privileges by these two classes of men. If we hire a physician we do so under conditions to which they stick as a class. We do not give them orders; on the contrary they order us around in what seems like a pretty arbitrary fashion. We do not pick out our own particular penance for our infractions of the law of nature but we take what they give us and are duly thankful. On the other hand we do not patronize their profession except in case of dire necessity and we dispense with their services as soon as possible. They have us at their mercy when we are sick but we assert our independence in short order when we recover. The fact is that some of us get well solely for the sake of getting even.

Is a draftsman a professional man? Is a tool-maker? It all depends on circumstances. If a retired physician should

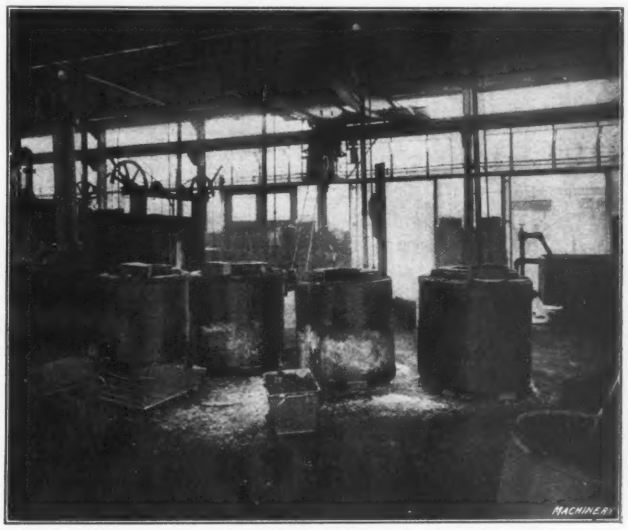

Fig. 13. Salt Bath Oil-fired Furnaces for tempering the Smaller Automobile Parts

decide to go into the machine tool business with no other training than what he had gotten in the course of his professional relations with machine tool builders, we should presume that his draftsmen and his tool-makers and his office boy would be able to maintain professional relations with him, but if a man with years of work at the machinist trade and at drafting should go into the same business, it would seem that he could readily hire men who would expect to do as they were told and do it in a spirit of cooperation or go elsewhere, just as would a machinist or carpenter.

A very considerable degree of professional pride is desirable in all workmen, but when that pride goes beyond the desire and purpose of doing the most creditable job possible under the circumstances which surround it, we wonder if there is not something wrong. Certainly among professional men there must be cooperation. Two surgeons who stopped to wrangle during an operation might find nothing more than a corpse as a result. So too, if a man in charge of a machine shop has demonstrated his fitness to hold the place he must really be a professional man among his employes, and should be so recognized by them.

* * *

A new method of obtaining very high temperatures from the electric arc has been developed. An ordinary electric arc is combined with a jet of oxy-acetylene or oxy-hydrogen to reinforce and increase its temperature. The simplest form of the apparatus has a high carbon electrode through which a blast of oxygen or air can be blown. The metal plate to be heated forms the positive pole and the carbon electrode the negative pole. The effect of the oxygen burning inside the arc is to produce a temperature much higher than that of the electric arc alone.

FIXTURES AND MACHINES FOR WIRE FORMING*

SUGGESTIONS FOR LAY-OUTS USED IN MAKING VARIOUS WIRE SHAPES

BY FRANK H. MAYOH†

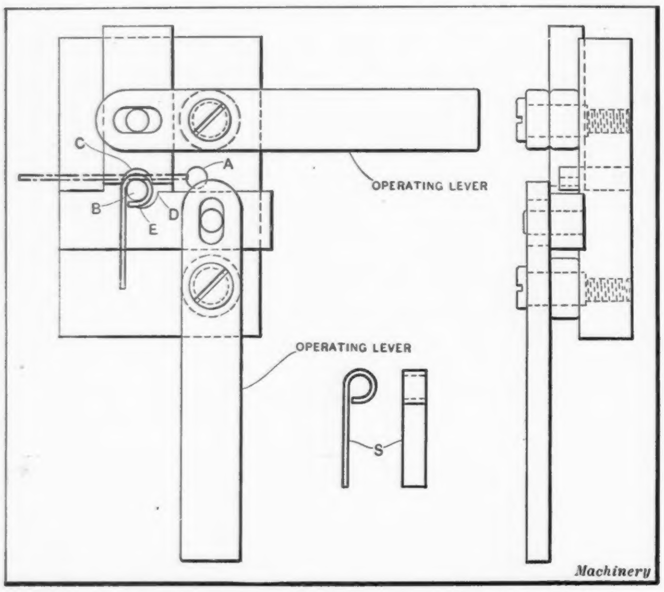

Fig. 1. Hand Operated Bending Fixture for producing the Piece S

WIRE forming from flat, round or irregular shaped stock is sometimes accomplished by crude methods and sometimes by very complex automatic machines. The choice of equipment is largely governed by the amount of work and the experience of the man who handles it. Inventors who have occasion to produce a large number of different wire shapes often depend upon some crude hand-operated device which results in a high-priced product, while manufacturers of wire products usually employ automatic machines which are capable of forming wire up to about ½ inch in diameter. The high output of such machines results in producing work that can be sold at surprisingly low prices. It is not the purpose of this article to go very deeply into the details of the mechanism which performs the different operations on the wire, as this varies considerably in different types of machines. The idea is to describe the operations around which the machines are built and to illustrate the principles involved by simple illustrations.

First, let us consider a piece of the form shown at *S* in Fig. 1. As only five hundred of these pieces are required, we cannot afford to rig up an elaborate machine and so a hand bending fixture is produced. This consists of a stop *A*, against which the end of the stock—which has previously been cut off to the required length—is held in the position shown by the dot and dash lines. It will also be seen that there is an arbor *B* around which the stock is formed, a jaw *C* which makes the first bend and a jaw *D* which forms the bend *E*. The jaws *C* and *D* are operated by levers which cause them to slide in and out as required. This fixture is held in a vise in such a position that the levers are free to move without interference.

The punch and die shown in Fig. 2 was designed for the purpose of producing the piece *T*, although an equipment of this type could be used for producing work of the form shown in Fig. 1 and a variety of other shapes. This punch and die are used in a power press, the method of operation being as follows: The blank shown by the dot and dash lines is put into the die and when the press is tripped, the punch is forced down against the work at *A*, bending both ends around the punch until the latter reaches the position shown. While the punch is descending, the beveled plunger *B* comes into contact with the plunger *C*, forcing it against the work by means of the pressure exerted on its beveled end. This plunger forms the small bend at the end of the work, thereby bringing it to the required form shown at *T*. When the punch rises, the spring *D* forces the plunger *C* out to the starting point, the movement being limited by the fetter screw *E*. Although these two methods do very well for bending small lots of work, pieces that are to be produced in large numbers can be manufactured far more economically in automatic machines where the wire is fed to the machine from a reel, cut off and bent to the required form, the machine running for days without requiring any particular attention from the operator.

As an example of the method followed in laying out an automatic machine, let us consider the operations and the method of reasoning followed in setting up for producing work of the form shown at *U* in Fig. 3. The first step is to feed the wire up to a stop and cut off a piece of the right length. The next step is to form the bends, while the small loops at the ends of the piece are twisted around two mandrels which are made to revolve by means of a rack. Fig. 3 shows a preliminary lay-out of the tools required for this purpose. The wire is fed up to the stop *A* by means of the feed-slide *B*, after first passing through straightening rolls similar to those shown in Fig. 8. The cam *C* pushes the form *D* forward against the wire and holds it in place until it has been cut off by the blade *E*. After the cutting operation has been completed, another rise on the cam pushes the form *D* forward again, thus bending the wire to the shape shown at *V*. The arbors *F*, which up to this time were held below the wire by means of a spring, are now released and forced up into place through the action of the cam *G* and lever *H*. The arbors are caused to revolve by means of a rack *J* and the pinions on the arbors, thereby forming the loops on the ends of the piece and finishing it to the shape shown at *U*. The wire is twisted around the arbors by the pins *I*.

After this sequence of operations has been completed, the machine is returned to the starting position by means of springs or return cams. At the same time, the work is picked out of the machine and thrown to one side by means of the hook *K* which is caused to move by the mechanism shown in Fig. 4. The lift *A* on the cam which controls this ejecting mechanism operates the spring hook *B* by swinging the arm about the pivot *C*. In this way the bevel *D* on the spring hook

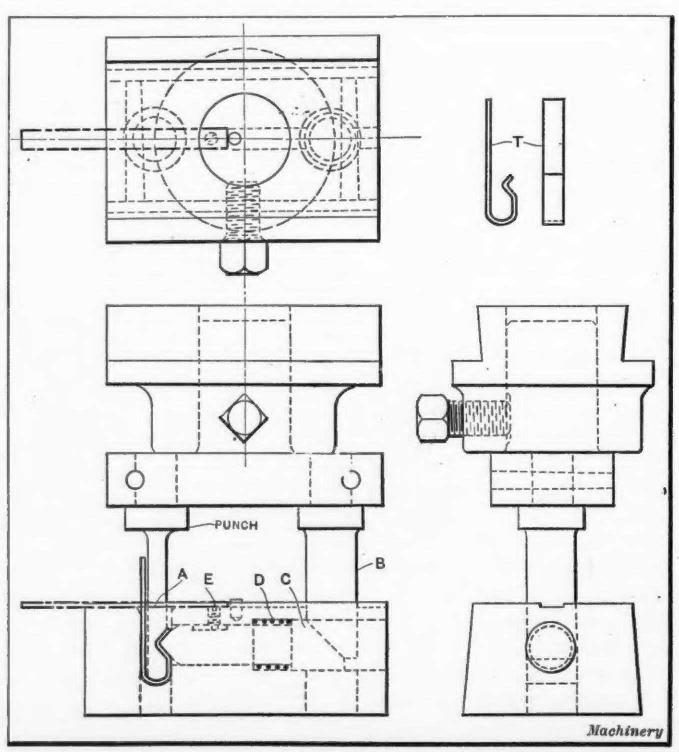

Fig. 2. Forming Punch and Die used in a Power Press to make Piece T

* For other articles on the subject of wire forming, see "Tools for Four-slide Automatic Wire Forming Machine" published in MACHINERY, February, 1912; "Wire Bending in the Foot Press," March, 1913, and "Four-slide Tools for a Wire Forming Job," June, 1913.

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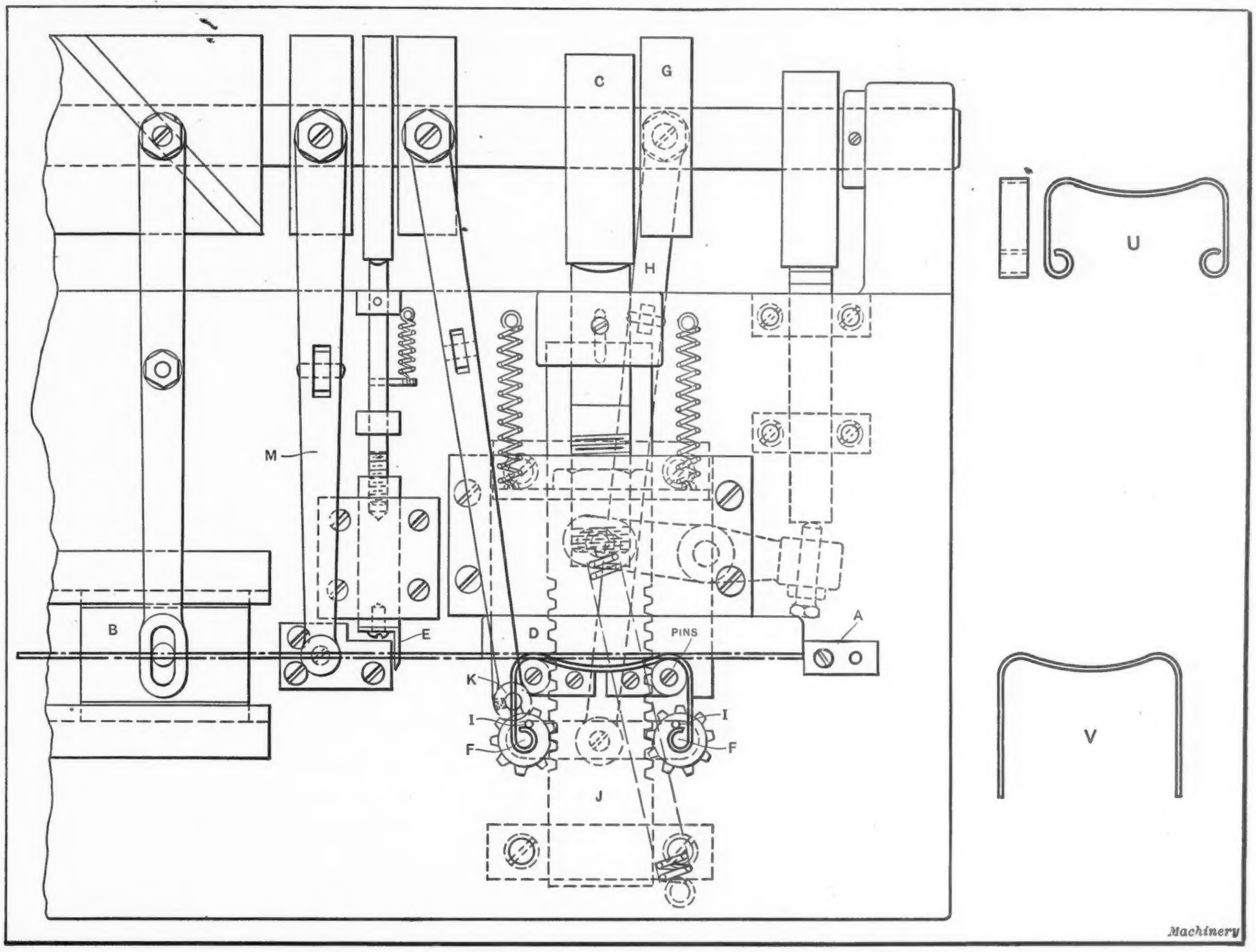

Fig. 3. Automatic Machine Lay-out for forming Piece shown in Detail at U

is sprung out by coming in contact with the work; the hook catches under the work in the position shown in the illustration, and when the hook is pulled back by the spring *E* it carries the work with it. When the curled ends clear the arbors about which they were wound, the work drops off the hook and falls down through a hole in the bed of the machine into a box placed ready to receive it.

This cycle of operations is repeated over and over again. The operations may be briefly outlined as follows: First, the wire is fed forward against a stop; second, the form is moved forward to hold the wire against a stationary form; third, the wire is cut off and the loose end is also held to prevent it from running back on the reel; fourth, the central part of the wire blank is bent over the form; fifth, the arbors engage the wire and are then revolved to form the curled ends; sixth, the arbors drop down, leaving the curled ends free; seventh, the finished piece is picked out while the machine is returning to the starting position. After these operations have been completed, the machine is ready to commence a second cycle.

Another point to be considered on most automatic wire forming machines is holding the end left loose after the blank has been cut off, in order to prevent the wire from running back onto the reel. This is step number three of the cycle of operations referred to in the preceding paragraph, and it must be so timed that when the feed-slide loosens its grip to move back and reengage the wire ready to feed the next piece forward, it will hold the wire and then release it before the feed-slide is ready to make its next forward movement. This is conveniently accomplished by the device shown in detail in Fig. 5 which is designated as *M* in Fig. 3. The operation of this mechanism is as follows: Just before the feed-slide lets go, the lift *A* on the cam causes the screw *B* carried by the rocker arm *C* to push the sliding pin *D* forward against the wire. In this way the wire is prevented from sliding back. As soon as the feed-slide has re-gripped the wire, the end of the lift on the cam is reached, thus releasing the pressure on the rocker arm and pin to permit the wire to be fed forward at the proper time.

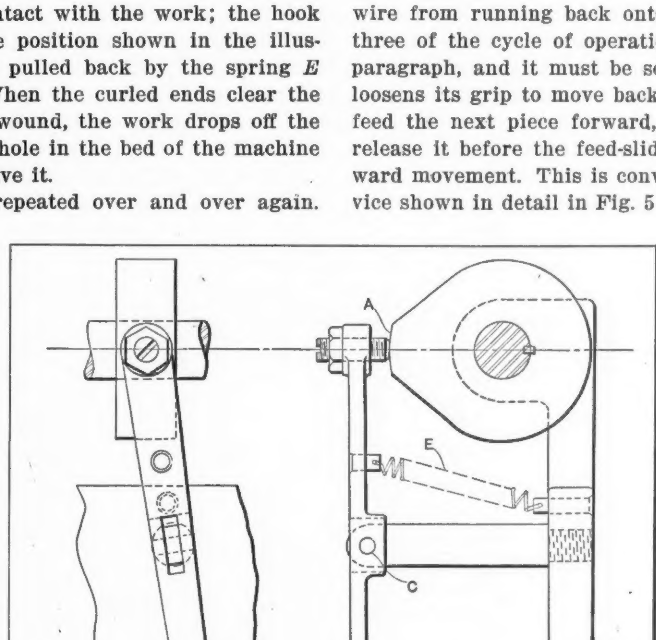

Fig. 4. Mechanism for operating Ejector K in Fig. 3

Small spring *W* in Fig. 7 is another good example of wire forming. The mechanism used for coiling this spring is also shown in this illustration, the operation being as follows: First, the wire is fed forward by means of a slide *A*, of similar design to the one previously described, and caught by the twisting spindle *B;* second, this spindle is caused to revolve

through the required number of revolutions by means of the bevel gears C and D which are driven by the arm E connected to the end of the shaft F. This mechanism is actuated by the cam G which pushes the connecting-rod H forward; after completing the operation, the return of the mechanism to the starting point is effected by means of the spring I; third, while coiling the spring, the feed-slide goes back and secures a fresh grip on the wire ready for feeding it forward for the next spring; fourth, the spring is cut off from the wire on the reel by means of the blade J which is operated by the cam K through the push-rod L and rocker arm M; fifth, the spring in its finished form drops through a hole in the bed of the machine into a box. These operations are repeated until the required number of springs has been formed and cut off. The work turned out by automatic wire forming machines is usually counted by special "counting scales."

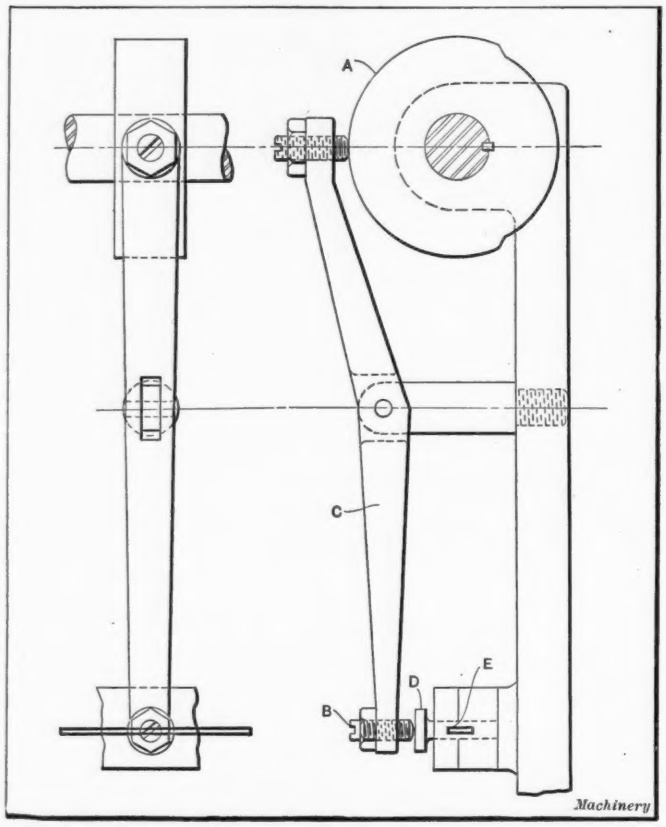

Fig. 5. Device for holding Wire to prevent it running back on the Reel

A more complicated wire forming operation and one which calls for very good work—both in design and set-up—is met with in automatic chain making machines. Such machines are used in the manufacture of watch chains and similar products, and produce chain of an indefinite length, which is afterward soldered where the ends of the links join. The chain is sometimes rolled to produce fancy links which give a more elaborate appearance. An automatic knock-off is provided on such wire forming machines to stop the operation in the event of the chain snarling up or any other unusual condition which would otherwise result in the waste of expensive wire. Fig. 6 shows the motions necessary in making chain of the form shown in detail at X in this illustration. Wire up to 3/32 inch in diameter may be used and links as great as ½ inch in length can be formed. The operations are as follows: First, the wire is drawn from the reel and fed up to the stop A by means of the feed-slide B. This slide is operated by the rocker arm C and cam D, as previously described. The cam has two movements, one for lifting the arm C up and down to bind or loosen the wire, and the other for feeding the wire. Second, the spindle E is caused to move forward until the jaws F hold the wire against the arbor G. Third, while the spindle is moving forward, the cam H lifts the rocker arm I which binds the wire J, thus preventing it from slipping back out of the wire guide K when the slide releases its grip for the purpose of obtaining a fresh hold. Fourth, the wire is cut off by the blade L which is operated by an arm M and cam N. After cutting off the wire, the blade is returned to its starting point. Fifth, the spindle E comes forward and bends the wire around the arbor G, partly forming the link in the jaws F. Sixth, the arbor G is moved slightly forward to set the partly formed link. Seventh, with

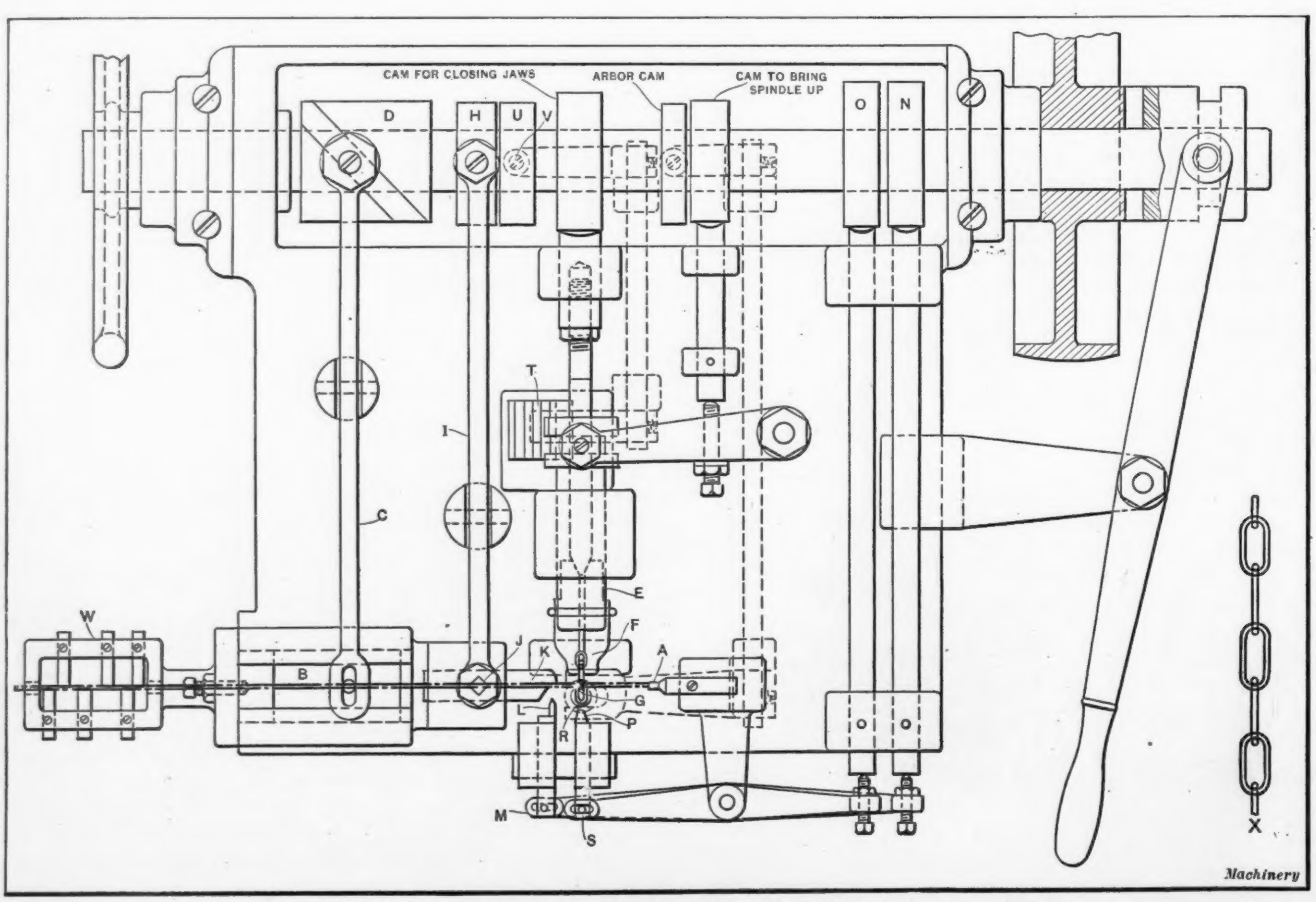

Fig. 6. Lay-out showing Motions of Machine which makes Jewelry Chain shown at X

all the parts of the machine held in this position, a cam O drives the header P against the link R in order to seal the link, the movement being obtained through the arm S. Eighth, another lift on the cam forces the arbor G down out of the link which is still held in the jaws. Ninth, by means of a segment T operated by the cam U and plunger V, the spindle E is caused to revolve through a quarter turn, holding the link in position to have the wire fed through it. The wire is fed up against the stop and the same sequence of operations repeated.

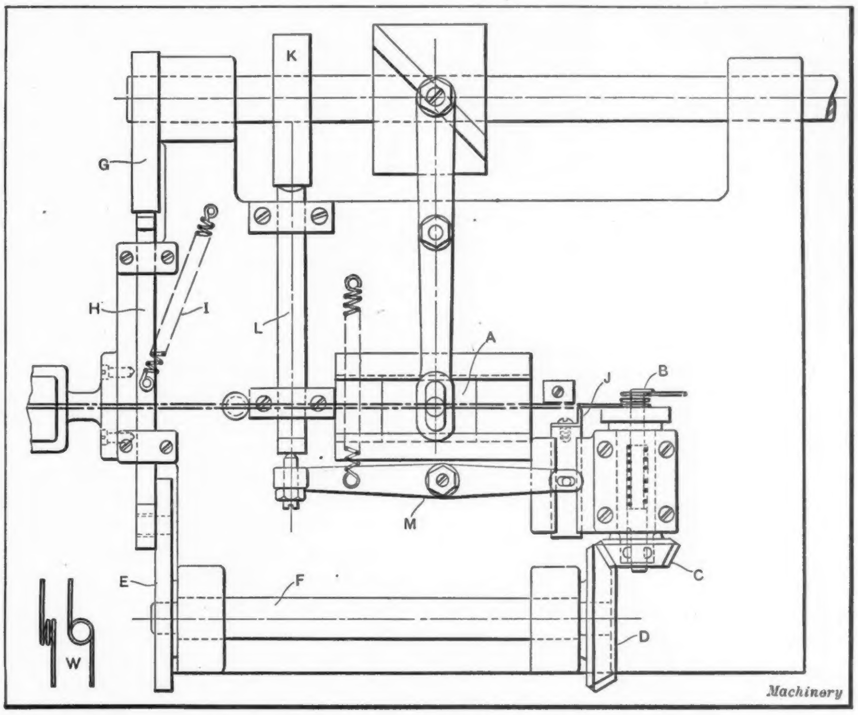

Fig. 7. Automatic Machine for coiling Springs of the Form shown at W

One of the vital points in the manufacture of wire articles is the straightening of the wire, which must be free from kinks or bends. For this purpose the wire is passed through a straightener shown at W in Fig. 6. A detailed illustration of another form of wire straightener is shown in Fig. 8. This consists of a series of rolls, between which the wire is passed to take the kinks out of it before being converted into any finished product. The efficiency of wire forming machines of the kind described in this article can be seen when it is understood that one man can easily operate a dozen machines and still have time to make up any special tools—such as arbors and jaws—required on subsequent work that these machines are to be operated on.

* * *

Some years ago a cylindrical grinding machine maker developed a design in which power was transmitted through a long shaft having two splines or keyways cut in opposite sides. The shaft was supported at the ends and by the driving pulley which traversed the space between the end bearings. It was found that the long shaft could not be successfully run if only two keyways were cut in opposite sides because of the tendency to whip and run out of balance. The trouble was overcome by cutting four keyways at points 90 degrees apart. The question is, why should four keyways cut at points 90 degrees apart stop the trouble that developed when only two were cut 180 degrees apart?

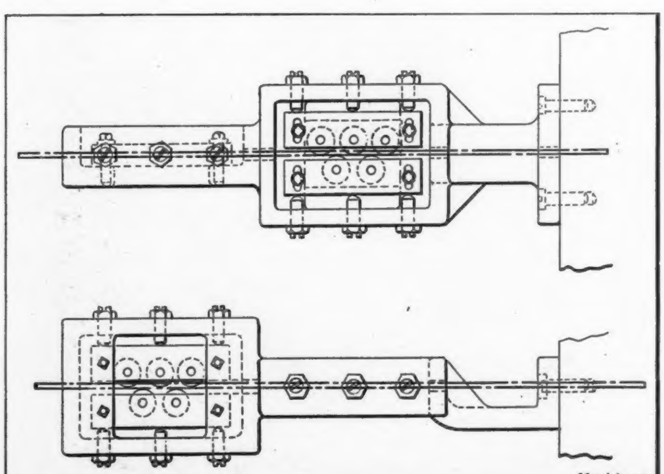

Fig. 8. Wire Straightener for preparing Wire to be formed

CAST-IRON AND BRASS BUSHINGS

BY CHARLES C. ANTHONY*

I have often wondered why the manufacturers of machine tools that are first-class in other respects do not put bushings in wherever possible so that when it becomes necessary to repair the machine the old bushings can be driven out and new ones put in place, thus doing away with a lot of extra work. The lack of bushings often means considerable expense, time and material to rig up something suitable to rebore holes. We have frequently had to do this with large punching and drawing presses, whereas if they had been designed and built with the repair end in view, many dollars could have been saved. I am sure that if prospective purchasers insisted on bushed bearings in the machines, the builder would be compelled to recognize the importance of doing it. I am also sure that is one of the first things I should consider in the purchase of machine tools. Too many machines are built at present in such a way that when the time comes to repair them, it can only be done at great cost, and sometimes at the expense of the strength of the machine, as provision has not been made for re-boring.

In this day of high-speed machines the question often arises as to the relative merits of cast iron and bronze for bushings. A great many manufacturers of machinery, in advertising their tools, place great stress on the fact of their having phosphor-bronze bushings. My experience has been that while bronze makes a good bushing for machines running at a very high speed and not being called upon to withstand any great pressure, cast iron will far surpass brass or bronze for bushings as regards wearing qualities. We have tried bronze bushings in certain machines and found them to last only about six months, while cast iron, with the same lubrication, would last several years. We have also used brass bushings in a number of twenty-spindle drilling machines, only to find them worn out in six months. They were replaced with cast iron and have been in service for several years. While it is true that cast iron, if poor in quality and rough in finish and not properly lubricated, will grind to powder, it is also true that poor brass or bronze roughly finished and not properly lubricated will do so likewise; but good cast iron, if smooth in finish and properly oiled, will far outwear brass or bronze. Then again, if the bearings warm up, bronze will expand more rapidly than cast iron, making bad conditions worse. We have, at present, a modern high-speed engine with a four-inch cast-iron wrist-pin which is showing excellent wearing qualities. Wherever we have tried cast iron in place of bronze or brass, we have always found the bushing to wear about 200 per cent better.

* * *

One of the large dealers in metals and alloys stated recently that since the beginning of the European war, tin has more than doubled in price and antimony has more than trebled. During the early part of August, there was a daily, not to say hourly, rise in the price of many metals.

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MAKING ALOXITE GRINDING WHEELS

PRODUCTION OF ALOXITE IN THE ELECTRIC FURNACE—MAKING VITRIFIED WHEELS AT PLANT OF CARBORUNDUM CO.

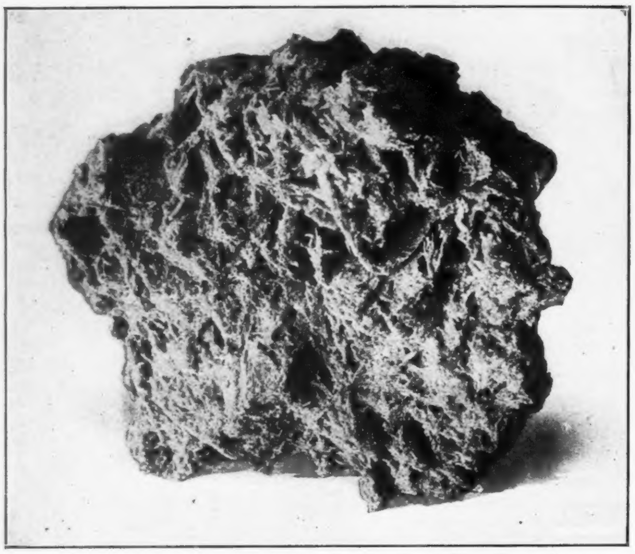

Fig. 1. Sample of Aloxite showing its Crystalline Formation

THE fast-cutting, artificial abrasives which are now produced, and the improved methods of bonding them together to form a wheel, are undoubtedly the two chief factors in the development of the modern process of grinding. At the present it is possible to grind successfully almost any kind of material, owing to the different characteristics of the abrasives now produced and the bonding processes that have been developed to meet various manufacturing requirements. As the characteristics of wheels necessary for grinding different materials efficiently have been determined as the result of experiments and experience, wheel manufacturers have endeavored by means of artificial processes to meet these requirements. That they have been successful is evident to anyone familiar with the quality and variety of work now produced by grinding, not only in machine shops but in many other lines of manufacture.

One of the more recent artificial abrasives placed on the market is known as aloxite and is the product of the Carborundum Co. of Niagara Falls, N. Y. Aloxite, like other artificial abrasives, is produced in the electric furnace and its manufacture and subsequent formation into grinding wheels involves many interesting processes. Aloxite is especially adapted for grinding steel or other materials of high tensile strength, as it possesses the necessary qualities of hardness, sharpness and toughness. A small piece of aloxite is shown in Fig. 1. As this illustration indicates, it is of crystalline formation so that when broken or fractured, sharp cutting edges are left which cause the wheel to cut rather than to work with an abrading action.

The raw material from which aloxite is made is the mineral bauxite which, when taken from the mines, is a clay-like substance that is an impure aluminum oxide. In the process of manufacture, the bauxite, which in the natural state is in granular masses and earthy form, is crushed and then calcined by feeding it through an inclined rotary kiln to eliminate all moisture prior to smelting. The calcined material is then elevated mechanically to a mixing machine (similar to a cement mixer) where anthracite coal is added to it. The coal is so proportioned as to reduce the oxides of silicon and iron in the bauxite during the smelting process, but leave the alumina unreduced.

Charging the Electric Furnace

The electric furnaces used in the French plant where most of the aloxite for the Carborundum Co. is produced, are circular in shape and equipped with two vertical electrodes suspended over the furnace opening. When a furnace is being charged, the bottom is first covered with a thick layer of the bauxite and coal mixture. The electrodes are then lowered until the ends rest upon this bottom layer. At first, it is necessary to form a path for the current by placing graphite between the electrodes, but as soon as arcs are formed between the ends of the electrodes and the charge becomes molten, it is no longer a non-conductor and the current passes directly through it. When the first layer is in a molten state, additional material is added and the electrodes are gradually raised and carefully regulated so as to maintain the proper resistance to the flow of the current and a constant amount of power for the furnace. This process of adding more mixture and raising the electrodes is continued until the furnace is completely filled.

Charging the furnace requires a period of from twenty-four to thirty-six hours. During the smelting process the reduced oxides of iron and silicon unite to form ferro-silicon, and the alumina is freed of practically all its impurities. As the ferro-silicon is heavier than the alumina, it sinks to the bottom of the furnace, where it is easily separated from the aloxite. After the smelting operation is completed, the furnace is allowed to cool, and then the ingot or "pig" is removed and crushed, as will be described later.

Fig. 2, which is a view in the French plant, shows several of these electric furnaces to the left and two of the large ingots, one being held by the crane. The shell of the furnace is of steel and the shape circular, the sides tapering inward slightly toward the top so that the shell can be lifted off the ingot. This steel shell is water cooled on the outside but does not have a refractory lining, the charge forming its own lining as the smelting process proceeds. The bottom is lined with a mixture of carbon and tar. Each furnace is mounted on wheels and has a suitable track so that it can be removed from under the electrodes. The alternating current used is

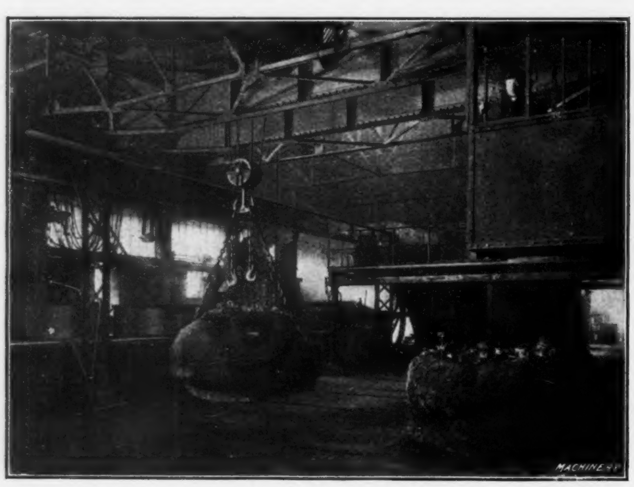

Fig. 2. Electric Furnaces (at Left) used in Production of Aloxite—Large "Pigs" or Ingots of Aloxite

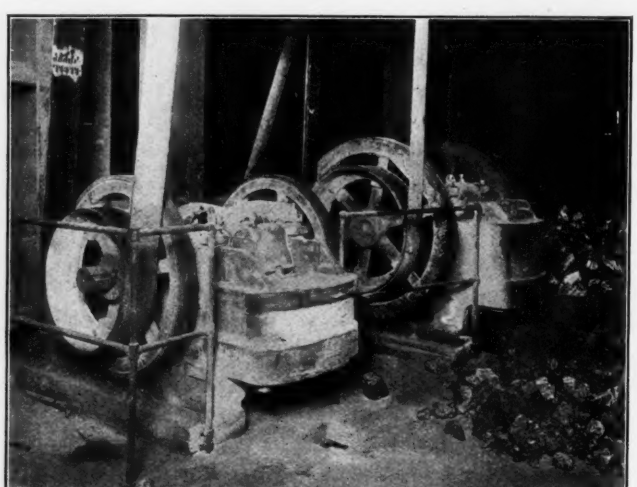

Fig. 3. Machines used for crushing Aloxite

stepped down by a transformer from 5000 volts to about 100 volts and is conducted to the electrodes by bus bars. These electrodes are of carbon. The practice is to operate several furnaces at the same time, the charging of the different furnaces being so regulated that the current consumption will be approximately uniform.

Crushing Aloxite Ingots or "Pigs"

A large "pig" or ingot obtained from the electric furnace, as just described, is first broken up into smaller pieces by the use of a drop weight or "skull cracker." These pieces are then crushed in ordinary rock crushers. Two crushers similar to those illustrated in Fig. 3 are used, the second one through which the material passes having the jaws set closer in order to break the particles finer. This preliminary crushing is followed by a magnetic separator treatment to remove any lumps of ferro-silicon which were not separated from the ingot. The aloxite is then re-crushed by passing it between plain rapidly revolving rolls. There are two sets of these crushing rolls. The first set of coarse crushing rolls receives the larger pieces which vary considerably in size, while the second set crushes the aloxite more uniformly and about as fine as ordinary gravel.

Screening Machines

This crushed material is next screened or graded by passing it over reciprocating wire screens through which the small pieces fall. A number of these screening machines are shown in Fig. 4. The screens not only have a reciprocating motion but are inclined slightly so that the abrasive grains feed along down the incline. The screen is composed of sections of different mesh, varying from fine to coarse from the feeding end, so that the grains are graded as they feed along and fall through openings at the side of the machine into the cans shown. The coarser screens are made of wire and those for very fine numbers are made of silk cloth. The oversize stock which is too coarse to pass through the coarsest screen falls off at the extreme end and is re-crushed in the second set of crushing rolls previously referred to.

Uniform grading is secured by close regulation of feed, by keeping the screens in perfect condition and by regular testing of the graded material. This testing is done at frequent intervals during the day by means of small testing machines carrying master screens. These show the exact amount of over size and "fines," and the slightest variation from the standard causes the material to be rejected. Complete chemical analyses are also made, as a standard chemical composition is essential in the production of high-class grinding wheels. Various other treatments are employed, such as chemical treatment, hydraulic classification or magnetic concentration to produce aloxite grain for special classes of wheels.

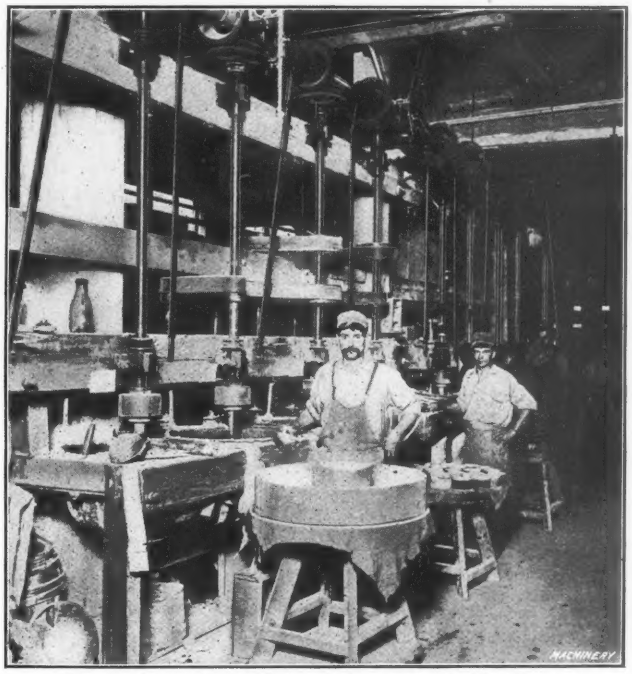

Fig. 5. Power-driven Mixing Kettle used when bonding by Vitrified Process

Bonding and Puddling or Mixing

One of the most important processes connected with grinding wheel manufacture is that of bonding the abrasive grains together in the form of a wheel. The three principal bonding processes are the vitrified, silicate, and elastic. As vitrified wheels are the most common, especially in connection with machine shop practice, this process will be described somewhat in detail in this article. The bond of a vitrified wheel is composed of suitable clays and fluxes which are mixed with the proper abrasive. By varying the amount and composition of the bond, wheels of different grade are obtained. The base of all bonds for vitrified wheels is feldspar or a fusible clay to which is added a refractory clay to decrease the fusibility of the bond. As the possible combinations of clays that may be used for bonding are almost endless, this is a branch of wheel manufacture that requires a great deal of experience and, at the plant of the Carborundum Co., it is in charge of an expert on ceramics.

The clays to be used are first dried to eliminate all moisture so that they can be proportioned by weight without the necessity of considering the weight of the moisture. Obviously, if there were an unknown amount of moisture in the different clays it would be impossible to determine the relative weights with accuracy. The bond, after being pulverized and

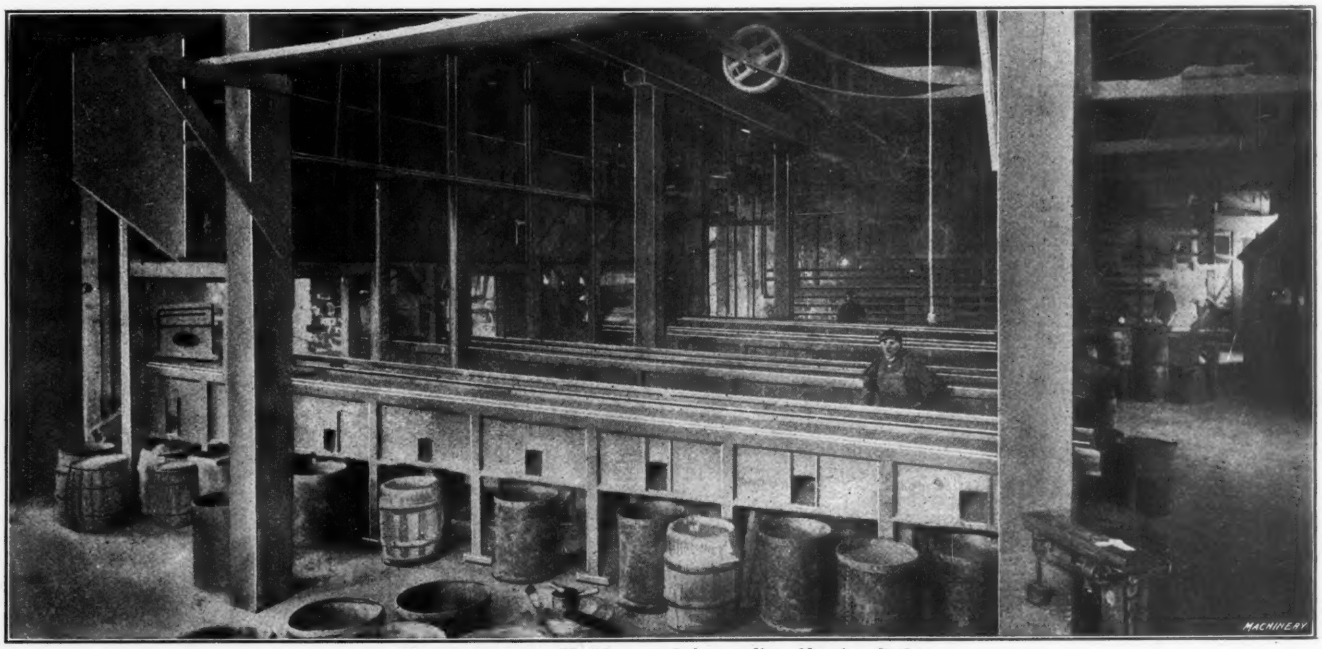

Fig. 4. Screening Machines used for grading Abrasive Grains

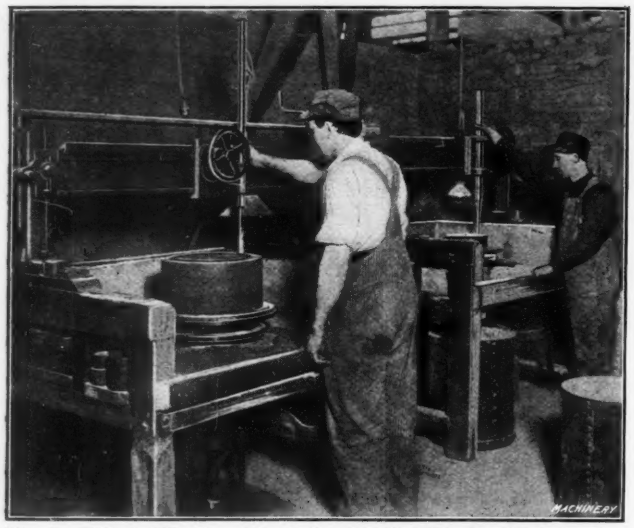

Fig. 6. Potter's Wheel used for truing Grinding Wheels prior to burning

screened to remove lumps, is mixed with the abrasive grains in power mixing kettles similar to those illustrated in Fig. 5. These kettles have rotating paddles attached to the vertical shafts shown. After the mixture of bond and abrasive is placed in the kettle, water is added and the mixing process begins. It is very important that the correct amount of water be added, the amount depending upon the coarseness of the abrasive and the composition of the bond. The coarser the grain, the less water is used. If there is too much water in the mixture, the grains and bond separate and the former, being heavier, sink to the bottom. An excessive amount of water also makes the wheels too compact, whereas if the mixture is too dry, they will be too coarse. The mixing requires several hours and depends upon the coarseness of the abrasive and the kind of wheel for which the mixture is intended.

Molding Vitrified Wheels

When vitrified wheels are mixed by the wet process in power driven kettles as described in the foregoing, they are molded as illustrated in Fig. 5. The mixture, which has the consistency of thick paint, is transferred from the mixing kettle to the mold, and when the mold is full the mixture is carefully worked to remove all air bubbles and insure a solid wheel. This operation requires considerable time when molding wheels which must be absolutely free from air bubbles such as those used for grinding glass, etc. The molds are then partially air dried in an open room to prevent formation of cracks. This preliminary drying is followed by a more complete drying in a heated room. When the molded wheels are hard enough to be handled they are ready to be turned to shape preparatory to burning in the kiln. The wheels are, of course, molded large to allow for turning and also to compensate for shrinkage in drying.

When very hard, close vitrified wheels are required, they are molded under the hydraulic press. Very strong molds must be used, as the pressures are enormous. For example, a 36-inch wheel would require a pressure of about 1000 tons. The bond and grain for pressed wheels are first mixed dry in a tumbling barrel, after which water is added until the proper consistency is obtained; the mixture is then spread evenly in the steel molds and pressed. The wheels are at once removed from the molds, dried, and "fired" in the same manner as other vitrified wheels.

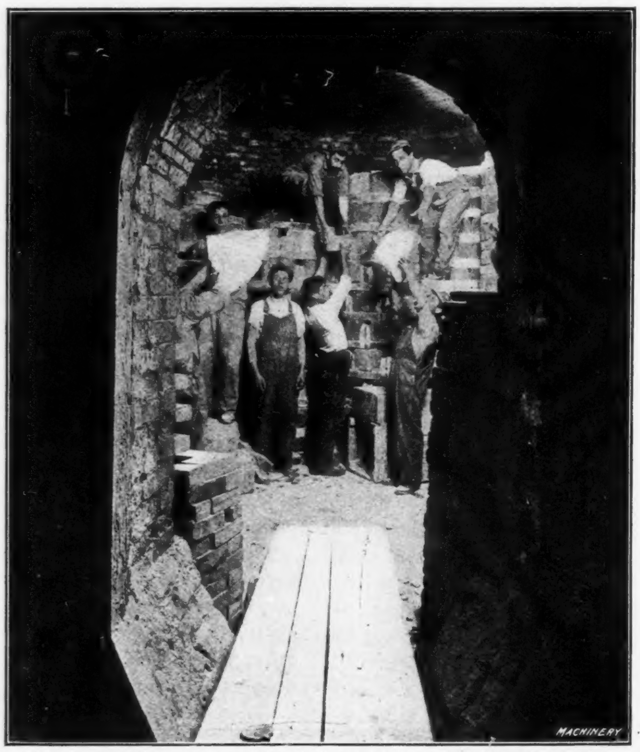

Fig. 7. Loading a Kiln with Grinding Wheels preparatory to burning

Truing Grinding Wheels on Potter's Wheel

The rough molded wheel is trued and turned to the required form on a potter's wheel, as indicated in Fig. 6. This is a very simple device which consists principally of a revolving table and a horizontal cross-rail along which the tool-slide is fed by hand. The wheel to be trued is not held in any way but is simply placed on the center of the table, which is made of plaster-of-paris. The tool used for turning plain surfaces is a piece of flat, unhardened steel. This tool can be fed either vertically or horizontally, and scales on the machine enable the operator to turn to the required dimension without taking any measurements.

The wheel is not reduced to the size finally required but an allowance is made for shrinkage in the kiln and also to provide material for a final truing operation after burning. This allowance depends upon the size and grain of the wheel. A coarse wheel requires a greater allowance than a fine one, other conditions being equal. In the operation of the potter's wheel, hand tools are used to a certain extent, particularly in the formation of special shapes.

Burning Vitrified Grinding Wheels

Another important process in connection with vitrified grinding wheel manufacture is the burning of the wheels in order to partially melt the bond and form a solid but porous wheel. Much skill and care is required to burn wheels suc-

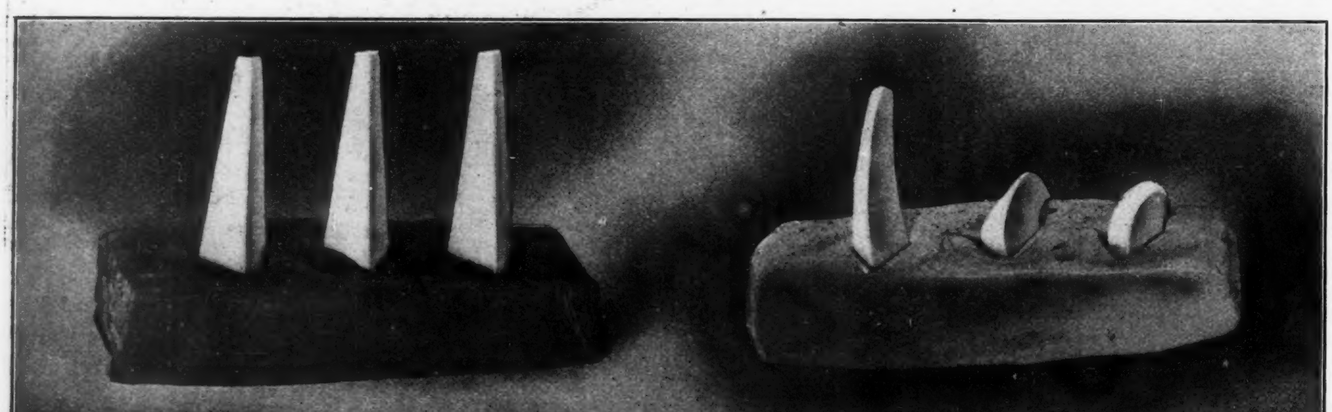

Fig. 8. Seger Temperature Cones which indicate Temperature of Kiln when burning Grinding Wheels

cessfully, as the temperature must be very accurately controlled for long periods. The wheels to be burned are stacked in a large brick kiln as illustrated in Fig. 7, which shows an interior view of a kiln as it is being loaded. The wheels are protected against the direct action of the flames and gases, by packing them in fire-clay saggers. When the kiln is full, the door is closed and luted with fire-clay and the burning begins. This continues without interruption for a period of from three to five days; the furnace is then allowed to cool slowly for a week.

The heat is derived from a coal fire beneath the floor of the kiln, and the temperature is regulated by the adjustment of dampers in the main and auxiliary draft tunnels. The draft through that part of the kiln containing the wheels is downward, and the heat is uniformly distributed by having draft openings in various parts of the kiln floor. The temperature in the kiln is gaged by Seger temperature cones. These cones, which are distributed throughout the kiln and are observed through small openings or "peep-holes," are in the form of triangular pyramids about two inches high which are held in a base as shown in Fig. 8. They are made in series or numbers which fuse at different temperatures and for this particular work, each "bat" or base contains three or four cones. When the first cone of the series fuses or becomes plastic enough to fall over, the temperature of the kiln is known and it is held at this temperature for a number of hours to insure uniform heating of all the wheels. The temperature is then increased until the next cone in the series falls over and it is maintained at this point, but is not allowed to rise high enough to fuse the last cone of the series. When two of the cones in a bat have fallen over, as shown to the right in Fig. 8, the man in charge of the kiln knows that the temperature at that point is somewhat less than that represented by the last cone of the series or the one still standing. In this way, the temperature is gaged and by having the cones distributed around the kiln, above and below and in the center, they also indicate whether or not the temperature is uniform. After the wheels are taken from the kiln they receive a preliminary inspection for flaws or cracks and then go to the truing department, as illustrated in Fig. 9.

Truing the Grinding Wheels

The sides of the wheels are first trued in machines similar to the one shown in Fig. 9. The wheel is held in an ordinary chuck and a revolving disk type of truing tool is used. This is held in a tool-post and is fed in against the wheel by the large handwheel shown, and in a lateral direction by an automatic feed. After the hole has been bushed with babbitt, the wheel is mounted on a true running spindle and the periphery is trued. The disk wheel type of dresser is also used for the periphery on large wheels, and diamond tools for small wheels.

Fig. 11. Method of determining Grade of Grinding Wheel

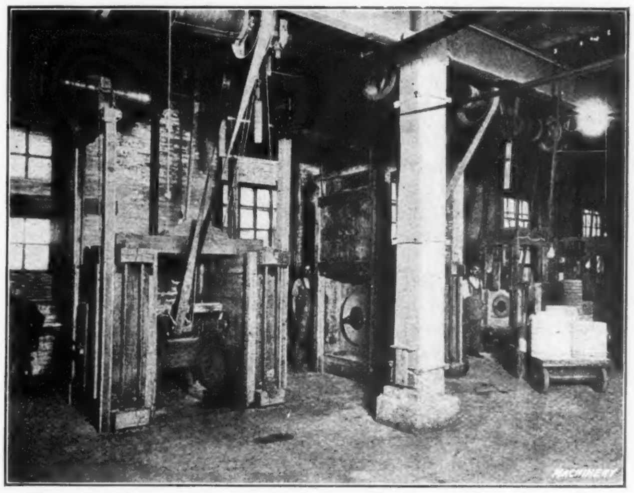

Fig. 10. Department where Grinding Wheels are given Speed Test

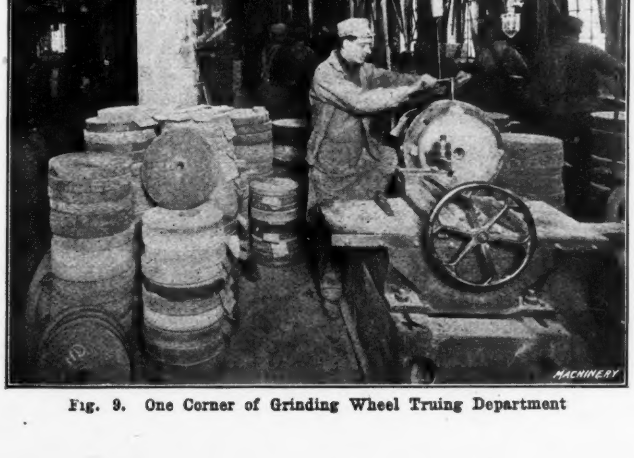

Fig. 9. One Corner of Grinding Wheel Truing Department

Balancing and Speed Test of Grinding Wheels

The trued wheels are next tested for balance by mounting them on an arbor and placing the latter on horizontal parallel ways. If the wheel is out of balance slightly, very light weights of standard size are temporarily attached to the periphery and if the standard weight for a given wheel does not counteract the unbalanced side, the wheel is rejected.

The department in which the wheels are given the speed test is shown in Fig. 10. This department is considered one of the most important in wheel making and every precaution is taken to insure that the wheels, as they leave the works, are perfect and safe to operate. The wheel to be tested is mounted on the spindle of the machine and then the sliding door at the side is lowered, thus enclosing the wheel in a heavy wooden box so that in case of breakage, no one will be injured. The speed for this test is about 70 per cent faster than the normal speed, and it is indicated by a direct-reading tachometer connected with the spindle of the machine. During this test, an internal stress is developed which is at least three times greater than the stress to which the wheel is subjected when running at the correct working speed. After a wheel is tested, the operator makes a duplicate written record of the test, one copy being attached to the wheel and the other filed in the records of the company. At the end of the day all records are sworn to before a notary.

Determining Grade of Wheels

The grade of a grinding wheel or the tenacity with which the bond holds the abrasive grains in place is determined by a hand test and requires considerable experience and skill. The tool used has a ball-shaped handle and a blade which is beveled on the end like a cold chisel. When making the test this beveled end is simply pressed into the side of the wheel as shown in Fig. 11, and is then turned or twisted. The resistance to this twisting movement indicates to the experienced man the grade. The delicate sense of touch is soon lost even by an expert who discontinues the work.

Many attempts have been made to supplant the hand grade test by a mechanical one, but up to the present time the simple tool in the hands fo an expert has proved to be the most reliable and practicable. After the grading test, the wheels are again carefully inspected and tested for soundness and then they are ready for the shipping department.

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AMERICAN INDUSTRIAL CONDITIONS AND THE OUTLOOK*

Step by step during the past three weeks we have been making our way toward a resumption of our foreign trade, following the paralysis of exchange and shipping facilities which came with the outbreak of war, and the progress made is now plainly evident. Our business men have met the situation calmly, their faith in the future strengthened by the effect on our domestic trade of the unprecedented harvest, the change in public sentiment toward legitimate business enterprises, our absolutely sound financial condition resulting from seven years of liquidation, and the settlement of our currency question so that we have an abundant supply of money for all legitimate purposes. Every one has noticed that there has been no approach to panic here.

Some exaggerated statements have been published regarding the benefits of the war to the United States, and this article is intended to be a conservative review of the situation as it affects our machinery industry, based on more than twenty-five years' personal acquaintance with European and American conditions.

Germany was ready for the war, and her vast army was mobilized almost by pressing a button; but neither England, France nor Russia was prepared. England's army is her weak point. The French army is still equipped with rifles of the 1886 pattern, although efforts have been made to substitute modern ones. Russia, during the past two years, has been spending vast sums for armament, in the construction of which many American machine tools have been employed. When the writer was in Russia last month, it was expected that the government expenditures would continue for at least two years, and machinery dealers there were looking for a continuation of active business during that period, although the recurring strikes of industrial workers imparted a sinister aspect to the future. The Russian army, on a peace footing, numbered 1,284,000 men, which sounds formidable to us, but most of these are required for garrison duty; 40,000 are needed for St. Petersburg alone, where there were 140,000 strikers last July. Germany needs no such garrisons in time of war for interior points.

Before the war Great Britain and Germany were close competitors in the manufacture of machinery and supplies. France was a small producer but increasing, Russia and Austria were buyers of machinery but not manufacturers. This war will probably cause great industrial as well as political changes. Unknown millions of producers have been suddenly withdrawn from the manufacturing industries and farms of Europe and turned into consumers and destroyers of life and property, so that virtually all producing is stopped in some of the countries at war, except where it can be carried on by old men, women and girls. Not only the countries involved, but also those that received their product, must continue as consumers to a large extent, and the United States is the only nation left to supply their demands freely; but time is necessary to build up an organization to do this.

The fearful load of debt which war entails means heavier burdens for the already overtaxed European peoples. Heavier taxes mean increased cost of living, of labor and of material—which will inevitably bring all European costs nearer those of our own manufacturers. Whatever happens to the three emperors who are responsible for the war, one result will surely be the transfer of some of their power to the people of Germany, Russia and Austria. This tendency is world wide, and in those countries needs only such an impetus as the war will give to become irresistible. Greater power for the people means higher wages, better living—and also higher costs for all kinds of manufactured products, and probably for farm products as well. All of these influences must work to our advantage by equalizing the cost of labor, which is the only advantage Europe now has over us.

No one who knows the German people can withhold his admiration for the wonderful capacity for organization, the matchless perseverance and far-sighted methods of handling public and private works which have developed in one generation the most powerful nation on earth. But the strength and military training of the Germans have made them over-confident, and begotten a war madness which will check their commercial progress for a generation. This was very noticeable when the writer was in Germany last summer during the break with England. The war fever possessed nearly every one, and only a spark was then needed to start the conflagration. This year the spark was applied, and like a flash of gunpowder all the powerful nations of Europe but one, were united against Germany.

Every one familiar with European industrial conditions has long seen that Germany would become our strongest competitor, and although she is hated and feared by all of Europe except Austria, her export trade everywhere has been increasing by leaps and bounds—in machinery and supplies more than one thousand per cent in ten years. She was reaching for the trade of the world and getting it. German makers of machinery and tools of all kinds have not only glutted their own markets, but those of England, France, Russia, Austria, Italy, the Asiatic countries, the Colonies and South America. No market was too small or too remote for profitable German cultivation. The only country where her mechanical products have not yet gained a foothold is the United States, and that is accounted for by our depression and the length of time necessary to perfect selling organizations covering such a large territory.

It will be years before the trade of Germany can recross the bloody barriers which will separate her at the close of the war from the countries she is seeking to destroy. Those countries will inevitably prefer tools and other products made by America—a nation always friendly; and our foreign machinery trade should reach the figures of our most prosperous years, so that whether we will or not, we stand to profit by the misfortunes of other nations.

Increased activity has already appeared in many domestic industries, such as the manufacture of prints, gloves, hosiery, carpets and woolens, pottery, toys, chemicals and nearly every business which has come into sharp competition with foreign products. A manufacturer of women's garments who uses two thousand gross of buttons weekly now buys them in America instead of Germany. Our powder mills have just started running double time on foreign orders. These are only straws, but they show the direction of the wind and indicate a tendency which will be followed in many other lines—*to buy here*, because we are almost the only source of supply for manufactured products. Every manufacturing business that is benefited helps the machinery industry.

We cannot expect business to revive over night; the situation is too complex. Some industries will be helped by the war, others will be injured; and while the immediate effect has been injurious, it is largely sentimental. Most American manufacturers, particularly those who make staple commodities, when they review the situation calmly, will find other markets opened by the war to replace those closed; and meanwhile our domestic markets under the influence of world-wide buying will expand gradually. Conditions here are such that the revival of business is largely dependent on sentiment. When a common sense view of the future prevails, the business pendulum will begin to swing the other way, and the swing will be a long one.

* By Alexander Luchars, publisher of MACHINERY, who spent three months in Russia, Germany and other parts of Europe, just before the outbreak of the war.

GAS PRODUCERS AND CHEAP HEAT AND POWER

The developments in gas producers and the improvements in the gas engine made in recent years have placed within the reach of the consumer small plants in which power can be produced as economically as in the very largest steam engine power stations. With the best types of gas producers it is possible to generate power with a fuel consumption of only one pound of coal per horsepower hour, and the coal used may be the very cheapest grade of bituminous, that is, "run-of-mine." The small producer power plant has a number of other advantages besides small fuel consumption and cheapness of fuel. It needs very little attention, and that attention for small-sized units may be given by a man regularly employed with other duties. The plant can be quickly shut down at night and started in fifteen or twenty minutes in the morning. There is no danger of disastrous explosion and the installation is compact and cheaply housed.

The lower operating cost of a gas producer plant compared with that of a steam engine plant is most pronounced in the case of small power installations wherein a boiler and steam engine of low efficiency often require five times as much fuel per horsepower hour as the gas producer plant of the same power capacity. In these smaller units the producer plant is somewhat more costly to install than the steam engine plant, but as the saving in fuel is so marked, the actual economy of the producer plant is beyond question. In the larger power installations, however, the comparative costs of highly efficient steam boilers and engines and producer cost equipment are about the same, and the saving of fuel effected by the latter is less. The gas producer, nevertheless, compares very favorably with the steam plant both in the matter of first cost and efficient power production.

The superiority of the gas producer plant over Diesel engines operating on fuel oil can also be demonstrated, probably without difficulty, as the oil used by the latter has of late years been increasing in price. The very high temperatures generated in the Diesel engine cylinders result in greater operating difficulties and higher costs of maintenance than in gas engines running on producer gas.

The gas producer undoubtedly has a great future, not only for stationary power plants, but also for marine propulsion. It requires less space than the steam engine power plant, and this, with the smaller amount of fuel needed for the same power, makes available larger cargo space. No smokestacks are required, and the fuel, unlike that for the Diesel engine, is available in practically every port of call.

It is not, however, for power purposes only that producer gas gives the greatest promise to manufacturers. It has been found to be a very cheap and valuable fuel for metal heat-treating furnaces. Installations of this type which have been in operation for some time have shown that at least one-half of the fuel cost, as compared with oil fuel, may be saved, and more uniform heats obtained in the furnaces. The great advantage of uniformity of heat is due to the fact that with producer gas the burners may be arranged along a pipe extending the full length of the inside of the furnace, whereas with oil fuel it is necessary to have the burners at the point where the oil and air mixture enter the furnace to force the flames against baffle plates. Inasmuch as it is also possible with producer gas to raise the temperature of the furnace to a required degree more quickly than with oil, there is an increase in the quantity of product as well as in the quality. The rapid growth of heat-treating plants and the probable great increase of such installations in all metal manufacturing plants making high-grade products make this advantage of producer gas of great importance.

* * *

MODERN MACHINE TOOL DESIGN

The designer of heavy machine tools which will satisfactorily meet present-day requirements has to provide better materials of construction than ordinary machinery steel and cast iron; he has to take care of heavier bearing pressures than were formerly the rule; and, lastly, he must safeguard gears, pulleys and other moving parts wherever practicable in order to prevent injuries to workmen.

It is not difficult to obtain better materials of construction for the smaller types of machines, but it is indeed a serious problem for heavy tools. In fact, at the present stage of machinery building, cast iron must be generally used for frames, slides, gears, faceplates, etc. To use steel castings is out of the question in some competitive lines. Machinery steel must be used for most shafts, large screws, etc. With these limitations what can be done? In the first place, the quality of cast iron must be made more uniform and dependable, and of higher tensile strength. Better design which tends to eliminate shrinkage strains and the concentration of stresses will help. In the case of gears, the double spiral tooth improves durability, reduces shocks and promotes steadier action.

Bearing pressures heavier than those safe with casual lubrication must be sustained by forced oil feed. Lubricating every important bearing constantly and in generous quantity by a circulatory system will be imperative. The splash lubricating system is satisfactory for gear trains that can be enclosed. In this design the requirements of safety and efficient lubrication are solved simultaneously.

Safeguarding dangerous points in machines will become second nature with the designer and will result in a decided improvement in the appearance of machines—a fact already realized, as is evident in comparing the designs of the present with those of ten years ago.

* * *

WHAT CONSTITUTES THE BEST DESIGN

The design of military equipment is often characterized by specifications of extraordinary difficulty and reckless disregard of cost. The United States government military authorities are well-known sinners in this respect, but perhaps no worse than those of other powers. The military expert takes himself and his profession very seriously. Victory in war is to be won at all hazards and the cost of guns and battleships is limited only by what the taxpayers will stand.

Excellence of design and construction are admirable, but the degree of excellence should be tempered with good sense and some regard for the mutability of human affairs. The military experts of a European power were racking their brains to devise a method for making an accurate army rifle with a hardened barrel. Smokeless powder has rapid corrosive and erosive effects on soft steel, and some alarmist demonstrated that the infantry rifles might be completely worn out and made useless in a protracted engagement. Hence the supposed need for more durable barrels. An American manufacturer of armory equipment demonstrated the fallacy of the idea. He showed that he could make barrels of soft steel so cheaply that it was better to re-barrel the rifles than to try to make hardened barrels. Another powerful argument against the practice is the fact that the designs of military equipment change so quickly that the manufacture of superlatively good guns would be wasteful.

The design of United States seige gun carriages is a good example of difficult specification and a royal disregard of cost. The carriages are built of thin steel plates riveted together and the plates must be shaped to templets and scraped to fit each other exactly. Parts requiring planing or turning must first be riveted together and then machined even though of a very unwieldy form. A carriage when completed looks like a pretty good job of riveted sheet steel work that might cost say $500, but the actual cost is not far from $11,000!

While it is true that military equipment, like fire apparatus, earns most when not in use, no engineer can look on such costly work without a feeling of regret at the probable waste. In manoeuvres and drills, field guns are subjected to the roughest possible usage and when not in service are left to stand out in the weather and rust. In a few years they become obsolete and go to the scrap heap. Bearing this in mind, who can say what is the best design in this work—that which is comparatively cheap, and possibly open to expert criticism, or that which is superlatively excellent and correspondingly costly?

PRODUCTION TOOLS FOR REO ENGINE CYLINDERS—2

SPECIAL JIGS AND FIXTURES AND MACHINING METHODS USED BY THE REO MOTOR CAR CO., LANSING, MICH.

BY DOUGLAS T. HAMILTON*

TO proceed with the machining operations on the Reo engine cylinders, the castings, after the first and second rough-boring cuts have been taken, as was previously described, pass through a long series of operations enumerated in the following. To make this description complete, reference will be made throughout this article to Fig. 1, which appeared in the previous installment.

Rough- and Finish-boring Inlet Valve Chamber Seats

The rough- and finish-boring of the inlet valve chamber seats *U* (see Fig. 1) in the cylinder casting is accomplished in the Moline adjustable spindle drilling machine shown in Fig. 10. This machine is equipped with a special fixture of the progressive type and has three work-holding slides so that it can be kept in practically continuous operation. The first two spindles carry the rough-boring cutters, and the last two the finish-boring tools. By referring to Fig. 1 it will be seen that the inlet valve chamber seat has two different diameters, namely, 2.768 inches and 2.328 inches. The larger bore penetrates 1.56 inch, and ends in a 45-degree taper leading to the 2.328-inch hole. This taper seat serves as a container for a gasket which makes the chamber steam-tight. The boring tools, which are shown at *A* in Fig. 12, are rotated at forty-five revolutions per minute, and the table is raised at a rate of 0.027 inch per revolution of the boring tools. The boring cutters *b* are made from high-speed steel and are held on the shank by a cap-screw *a*, being kept from turning by keys *c*. The upper portion of this seat is tapped later.

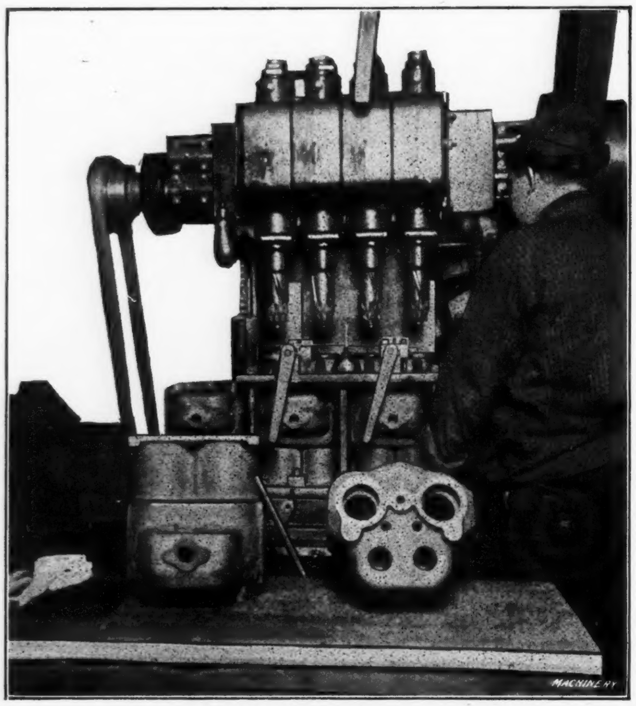


Fig. 10. Rough- and finish-boring the Inlet Valve Chamber Seats on a Moline Adjustable Spindle Drilling Machine

The work-holding fixture used on the machine shown in Fig. 10 is of interesting construction and is illustrated in Fig. 11. Upon referring to the latter illustration, it will be seen that, as in previous cases, this fixture is of open construction consisting of a bed *B* and top plate *C*, held together by upright stanchions *D* at the front; the back is a full casting with openings to provide clearance for chips and the work.

The individual work-holding slides *E*, of which there are three, fit in dovetail slides in the base of the fixture, as indicated in Fig. 11. The engine casting *A* is located on the slides from the previously reamed holes in the flange by pins *F* and held down by heel-clamps *G*. These clamps are held up by open-wound coil springs to facilitate loading and unloading. Located in the base of the fixture is a rack *H*, operated by a pinion *I*, which is rotated by a handle on shaft *J*. Fulcrumed on a pin in rack *H* is a latch *K*, held up by flat spring *L*.

In operation, the work-holding slide *E* is laid on top of the extension of the fixture, the rack *H*, prior to this, being moved out as far as it will go. The slide then butts up against the latch *K*, and as the rack is moved in again by the handle on shaft *J* the casting clamped to the slide is brought to a position under the boring and reaming tools. The adjustable stop-screw *M* butts against the casting of the main fixture when the work-holding slide has reached the proper position in alignment with the spindles of the drilling machine. The handle *N* is then operated, and as this is connected by links to cams or eccentrics *O* which are held to spring plungers *P*, a movement of this handle to the left forces the plungers into bushed holes that locate the work-holding slides in the proper relation to the spindles of the machine.

By having three slides for holding the work it is possible

* Associate Editor of MACHINERY.

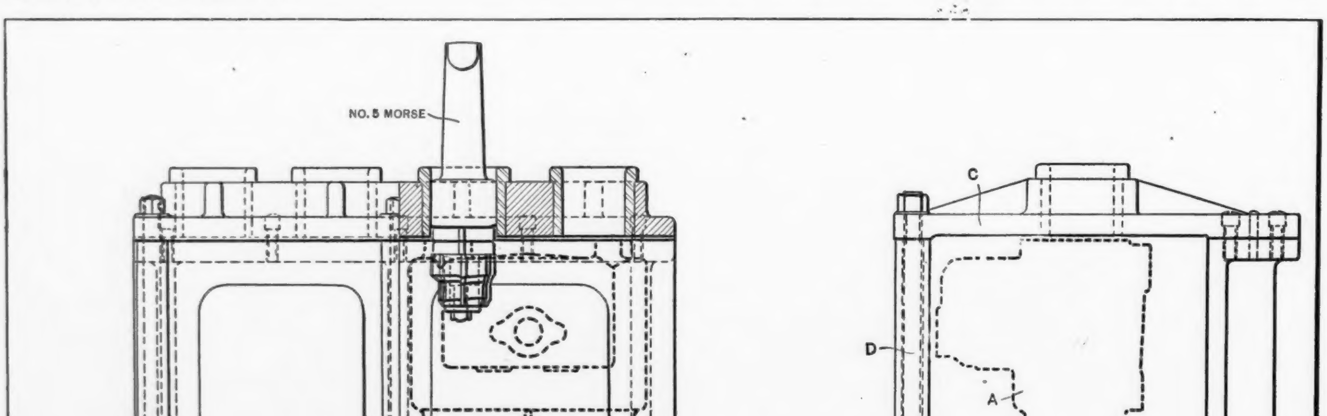


Fig. 11. Rough- and Finish-boring Fixture for Inlet Valve Chamber Seats used in the Machine shown in Fig. 10

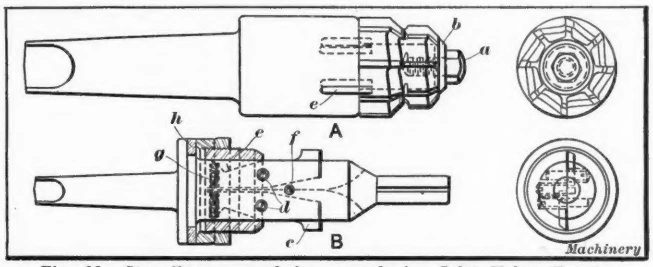


Fig. 12. Step Reamer used for rough-boring Inlet Valve Chamber Seats and Special Recessing Tool for the Valve Seats

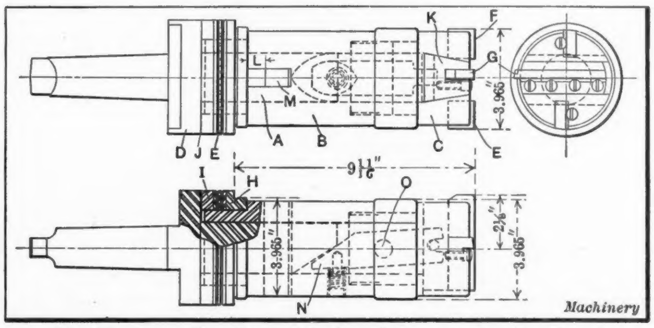


Fig. 13. Expanding Type of Tool used for recessing the Top of the Cylinder Bore

to keep this machine in practically continuous operation, and a production of 200 cylinder castings is turned out in nine hours. In addition, the fixture is very simple to operate and admirably adapted to progressive drilling of this kind. The open-type construction is also commendable.

Following the rough- and finish-boring of the inlet valve chamber holes, the castings are taken to a Baker vertical high-speed drilling machine of the type shown in Fig. 19. Here the cylinder bores are counterbored to the proper depth and recessed at the top or explosion chamber. The recessing operation serves two purposes: In the first place, it facilitates grinding the cylinder bores, and in the second place obviates knocking when the cylinders have been in use for some time. As the piston travels up to the same point in the explosion chambers at each stroke, it is apparent that as soon as the bore commences to wear a slight shoulder will be formed at the upper end of the piston stroke. This causes knocking to take place in the cylinder at every stroke, and in order to obviate this trouble it has been found advisable to recess the cylinder to a diameter larger than the bore at this point, so that at the end of its up-stroke the piston will pass into a clearance space.

The tool for performing this recessing operation is shown in Fig. 13. It consists primarily of a body *A* machined to fit into the spindle of the drilling machine, and turned down on its lower end to fit into sleeve *B*. The lower end of the sleeve is formed into a cutter-head *C*, carrying two high-speed cutters *F*, which face the cylinder to depth, and two recessing cutters *G*. Driven onto the extended shank of sleeve *B* is a collar *H* and between this collar and the flange *D* of the cutter spindle is a ball thrust bearing *E*, and a thrust washer.

In operation, the action of this tool, which is shown in the position that it occupies at the final downward movement of the cutter spindle, is as follows: A slotted washer (not shown) is inserted between the spindle collar *D* and the thrust washer located directly beneath it. This holds the sleeve *B* down, causing the recessing tool *G* to collapse into the sleeve, thus making a solid end-cutting tool with two facing tools *F* exposed. The spindle is then fed downward and the cylinder faced to depth, as determined by stop-collar *H* against the flange of the cylinder.

The slotted washer is then removed, and as the tool continues to feed downward, the spindle *A* advances into sleeve *B*, and the beveled end of the spindle, contacting with the spring-controlled operating wedge *N*, forces out the cutter-slide *K*. Wedge *N* is fulcrumed on a pin *O* held in the cutter-head *C* which is screwed into the nose of sleeve *B*. The action of forcing out the cutter *G* continues until spindle collar *D* contacts with the thrust washer located beneath it, which occurs when the proper recessed diameter has been reached.

The next operation, which is of a simple character and is accomplished in a single-spindle drilling machine, is to drill, counterbore and tap for the spark plug holes *V* shown in Fig. 1. There are two of these holes to be drilled and tapped in each casting. The drills are 23/32 inch in diameter, and the tap is a ½-inch pipe tap. The hole is counterbored 1 inch diameter by 5/16 inch deep. This operation is clearly shown at the section on *M-N*.

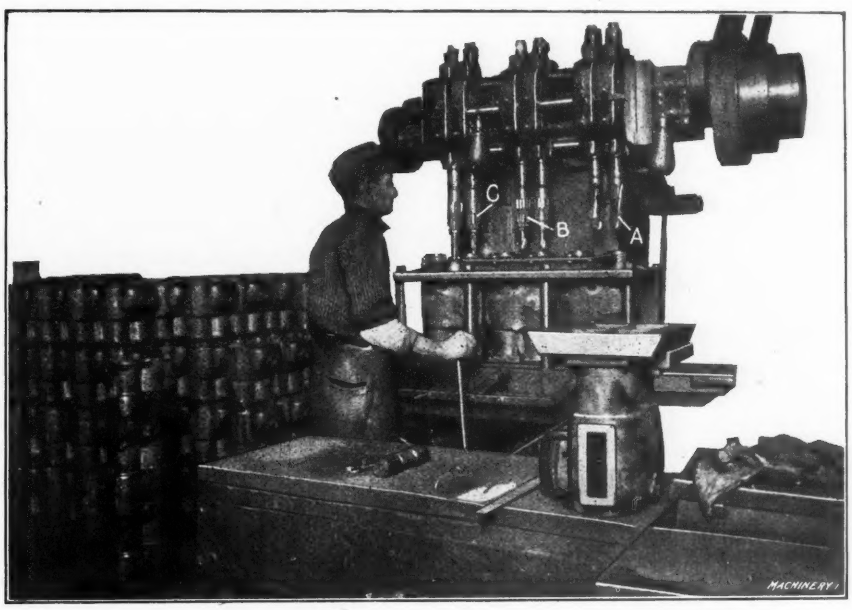


Fig. 14. Drilling, rough-boring and finish-reaming Exhaust Valve Seats

Drilling, Boring and Reaming Exhaust Valve Seats

Another interesting method of handling automobile engine cylinders while machining the exhaust valve seats is shown in Fig. 14. The machine used is a Moline six spindle drilling machine equipped with a

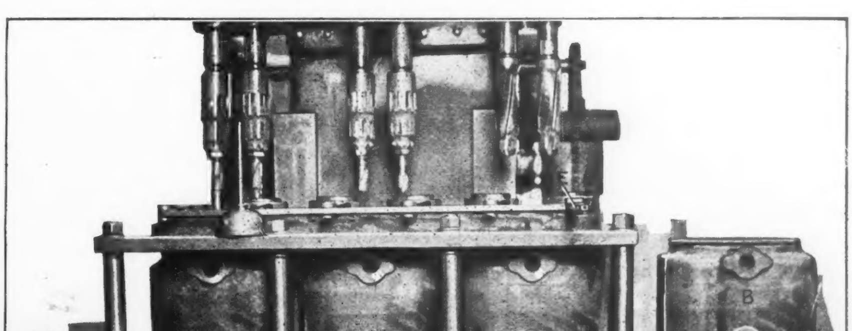


Fig. 15. Close View of Progressive Type of Jig used in the Machine shown in Fig. 14

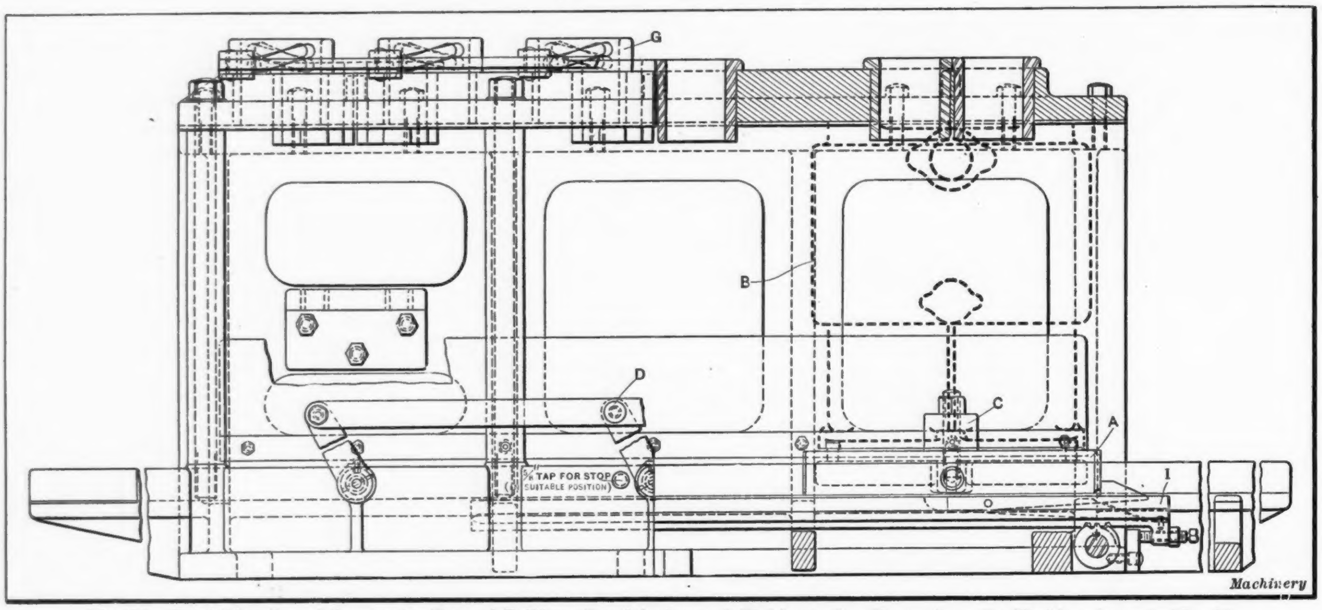


Fig. 16. Front Elevation of Progressive Type of Drilling, Rough-boring and Finish-reaming Jig used on the Machine shown in Fig. 14

special fixture of the progressive type, somewhat similar in construction to that shown in Fig. 11. This fixture, instead of having three, has four work-holding slides, and the operations performed in it are somewhat different from those previously described. Three of these work-holding slides are kept in continuous operation. The first two spindles *A* of the machine rough-drill the exhaust valve covers and valve seats, the second two spindles *B* carry tools that rough-bore the exhaust valve covers and valve seats and drill the exhaust valve stem guide holes, whereas the third two spindles *C* carry the finish-reaming tools for the exhaust valve covers, valve seats and valve stem guide holes. These tools are rotated at sixty-five revolutions per minute and the table is given an upward feed of 0.012 inch per revolution of the tools.

Fig. 15 shows a close view of the fixture. By referring to this illustration and also to Figs. 16 and 17, a good idea of the construction and operation will be obtained. All three illustrations have the same reference letters. The slides *A*, of which there are four, carry four locating pins which fit into the previously reamed holes in the flange of the casting *B*. In addition, the casting is held down on the slide by two toe-clamps *C*. The method of operating this fixture is as follows: The operator, in starting, of course, only rough-drills in the first position; then the slide is shifted to the next position.

Handle *D* withdraws the locking plungers from the bushed hole *F* in the slide, and handle *E* withdraws the bushings *G* which are used as locating members and fit into the previously machined inlet valve chamber hole. Handle *H* that moves the rack *I*, see Fig. 16, is then operated and carries the next slide into position. This part of the fixture is similar in construction and operation to that shown in Fig. 11. One slide forces the other along, as the rack only carries in the outermost slide or the one located to the right in the illustration.

Upon the completion of the drilling operation, the first casting is shifted to the next position by a second slide that carries a rough casting. Then when the table is raised one casting is drilled and another one rough-reamed. Upon lowering the table, the locking plungers are again withdrawn by handles *D* and *E* and handle *H* is rotated. The next slide is then forced into position and as the table rises again three operations are being accomplished, namely, rough-drilling, rough-drilling and boring, and finish-boring and reaming. After the fixture is filled up, the operations are continued, so that a completed casting is turned out at every drop of the table.

A better idea of the method used in locating the castings will be obtained by referring to Figs. 16 and 17. Bushings *G* which are provided with cam grooves are raised and lowered by pins fitting in these grooves and operated by a lever connected by links to the various operating pins. Bushings *G* fit into the previously machined inlet valve chamber holes and serve to preserve the required relation of these holes and the exhaust valve holes. This fixture operates very rapidly, and as one idle or extra work-holding slide is provided, it is practically unnecessary for the machine to stop working, the operations being almost continuous. A production of 150 finished castings in nine hours shows that this fixture is all that could be expected in the way of efficiency.

The roughing and finishing tools used for the exhaust valve seats are illustrated in Fig. 18, which also shows the depth of the various bores. By referring to this illustration and also to the view of the cylinder in Fig. 1, the nature of the operations will be clearly understood. The lower hole *a* is drilled 0.781 inch diameter and is then reamed with the last tool to 0.8125 inch diameter. The next bore *b* is drilled to 1.6875 inch and reamed to 1.750 inch. The next diameter is drilled to 1.9375 inch by tool *A* and reamed to 2.017 inches, these being the finished dimensions, and the largest diameter is finished to 2.25 inches. The entire seats are finished complete before the casting leaves the machine, all edges being beveled to 45 degrees as indicated. The total drilling and reaming depth is about $5\frac{5}{8}$ inches.

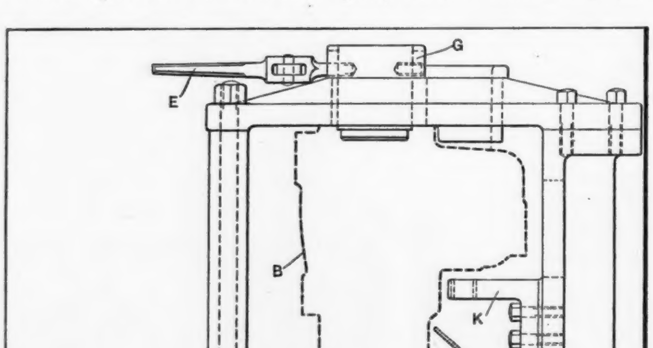


Fig. 17. End View of Jig shown in Fig. 16

The roughing and finishing boring tools are worthy of particular attention. They are shown at *A*, *B*, *C* and *D* in Fig. 18. *D* shows the shank of the two tools *B* and *C*, which are similar in construction. These shanks are made from one piece of machine steel, packhardened and ground, and are bored out tapered on the lower end to carry the drill in one case and the pilot reamer in the other. The drill and reamer have tapered shanks and the rough- and finish-boring reaming tools are held on the

main shank of the holder by a nut as illustrated. It will also be noticed that the lower faces of the two upper reamers, both roughing and finishing, are provided with slots in which the projections on the upper members of the other roughing and boring reamers fit. This prevents them from turning and avoids the necessity of having a keyway on the arbor. The holes in these rough- and finish-boring tools are made a good fit on the shank of the holder so that they are very rigidly supported, eliminating any chance of inaccuracy due to movement of these tools. The leader of the finish-reaming tool is guided by a bushing in the bracket *K* of the fixture shown in Fig. 17, and a guard *L* is also added to deflect the chips from the side of the fixture to the table of the machine.

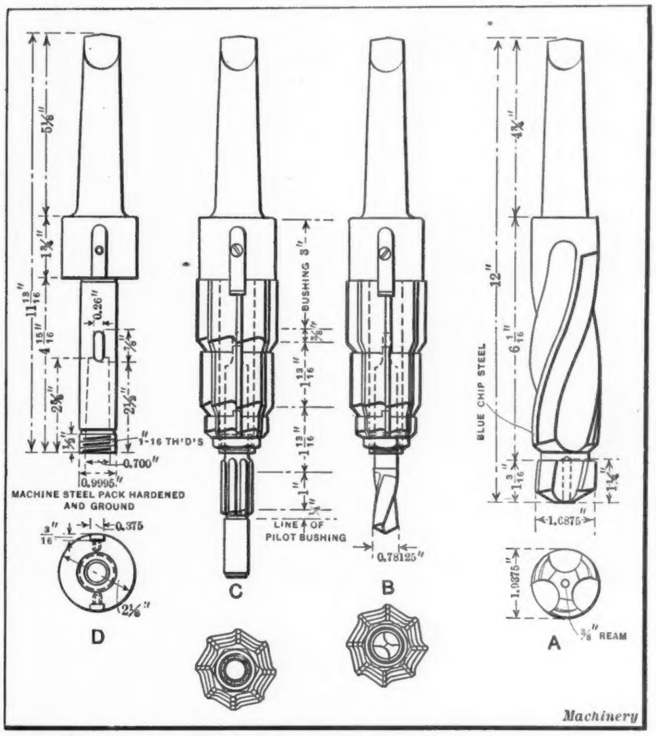


Fig. 18. Roughing Drill, Roughing Counterbore and Finish Counterbore and Reaming Tool for completing the Exhaust Valve Seats. These Tools are used in the Machine shown in Fig. 14

Facing, Recessing and Tapping Valve Holes

Following the drilling, rough-boring, finish-boring and reaming of the exhaust valve seats, the next step in the machining operations is to face the valve hole bosses, counterbore the base of the chamber *e* and recess it larger than the valve hole. Reference to Fig. 1 will make clear the operation that is performed here. This facing and recessing operation is accomplished in the Baker high-speed drilling machine shown in Fig. 19, using the tool shown at *B* in Fig. 12. This tool is built on the expanding principle.

The recessing is accomplished by two inserted high-speed steel blades *c* which are retained in a slot in the body of the holder by two fulcrum screws *d*. The adjustment of these cutters is accomplished by moving the locking-nuts along the sleeve *e*, this action forcing the cutter blades in or out, depending on the movement given to the nut, and thus increasing or decreasing the diameter due to the tapered portion of the cutters passing over the screw *f*. These cutters are kept together, that is to the smallest diameter, by an open-wound coil spring *g*, and the thrust of the adjusting nut is taken by a bronze washer *h*.

The holes for the exhaust valve cover and inlet valve chamber are then tapped in the Baker high-speed drilling machine shown in Fig. 19. The two inlet valve chamber holes are tapped 2⅞ inches by 12 pitch, the bore being 2.768 inches. The two exhaust valve cover holes are tapped 2⅛ inches by 12 pitch, the bore being 2.017 inches. It may be interesting to note here a few facts concerning the taps that are used for this purpose.

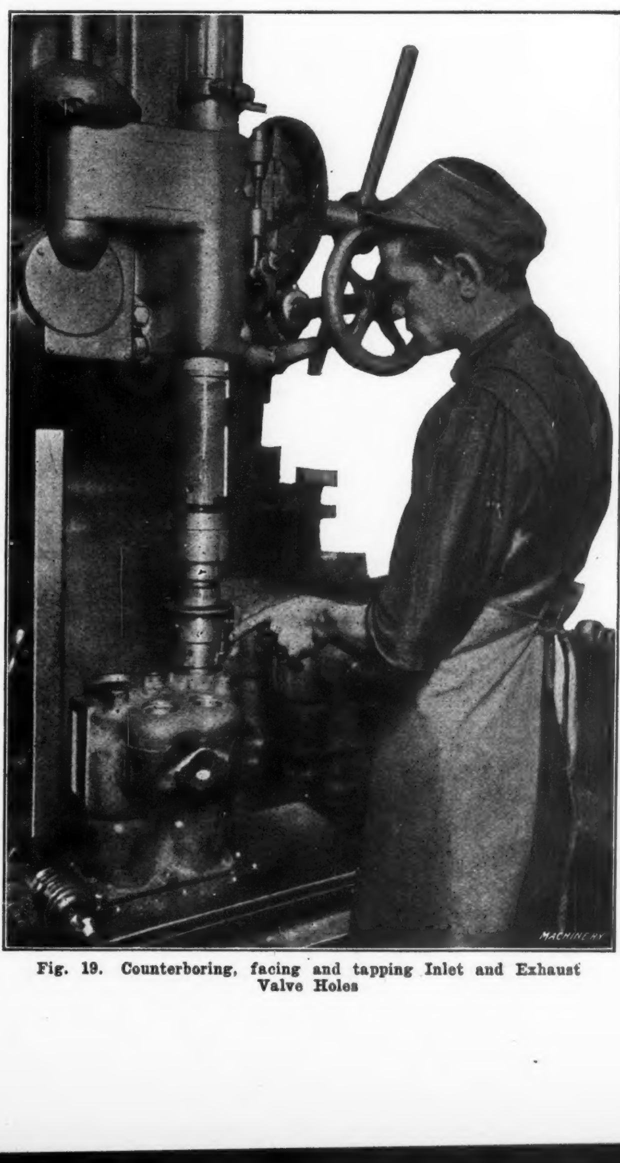


Fig. 19. Counterboring, facing and tapping Inlet and Exhaust Valve Holes

They are Murchey removable chaser taps, and both of these tap holders have been in use for over a year. By supplying them with only three sets of chasers it has been possible to turn out 16,000 cylinder castings or 32,000 tapped holes with three sets of chasers.

Miscellaneous Drilling, Tapping and Counterboring Operations

Following the principal operations outlined, the additional steps will be given in the order in which they are performed. The first operation is to drill six holes *f*, see Fig. 1, for the waterjacket plate. This is accomplished with a multiple drill head which carries six 13/64-inch drills. Fifty engine castings are turned out per hour in this operation. The next step is to remove the cylinder to a single-spindle drilling machine, where the two vent holes *g* are drilled; holes *h* and *i* are also drilled for the water connections, two of these being tapped, and in addition the two holes *j* for the support for the valve rocker are drilled and tapped. Following this operation, the valve stem guide holes are faced on a single-spindle drilling machine. This is a comparatively simple operation to perform and 100 cylinder castings are turned out per hour.

The next operation, which is also accomplished in a single-spindle drilling machine, is to drill and tap four holes for the inlet and exhaust water pipe connections, and counterbore two holes. Following this, the casting is removed to another single-spindle machine and three ½-inch pipe tap cleaning holes are machined. Also the holes for the inlet and exhaust pipes are reamed. For these operations the casting is held on a rotating fixture which is swung around to bring the various holes into position in line with the spindle. While these operations are of a minor character, they nevertheless count in the production of a cylinder and must be taken into consideration.

Final Boring Operation

The cylinder casting, after having had the minor operations enumerated performed, is now ready for the final boring operation. This is accomplished on a Moline four-spindle boring machine, equipped with a fixture somewhat similar in design to that shown in Fig. 10. The fixture is supplied with four slides so that while two are in operation the other two can be unloaded and loaded, thus practically keeping the machine in continuous operation. In this final boring about 0.045 inch is removed from the diameter, leaving 0.010 inch for the final

grinding operation. In the finish-boring, 160 cylinder castings, or 320 cylinder bores, are turned out in nine hours. The object in performing three rough- and finish-boring operations on the cylinder previous to grinding is to remove all strains from the casting and to obtain a perfectly round hole as well as to get the bore absolutely straight and eliminate any possibility of securing poor work on the grinding machine. The grinding operation is primarily to secure a perfectly smooth bore, and the rough- and finish-boring operations are depended upon to make the bore cylindrical and straight. Grinding, under the most favorable circumstances, is a somewhat expensive operation, and the less material that can be removed in this operation the better. However, grinding of the cylinders is acknowledged to be about as satisfactory a method of securing a true bore as can be employed.

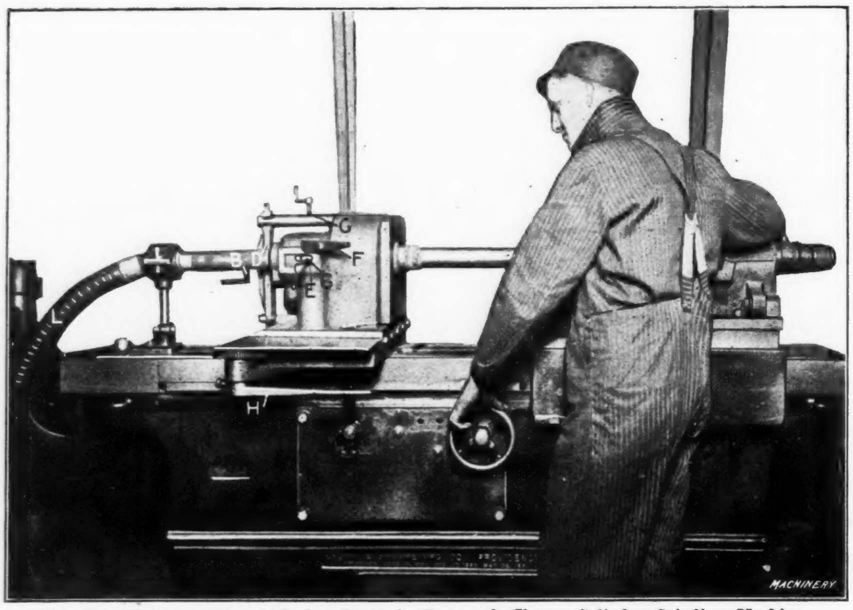


Fig. 20. Finish-grinding Cylinder Bores in Brown & Sharpe Cylinder Grinding Machine

Finishing the Cylinder Bores by Grinding

One of the great difficulties met with in grinding cylinder bores is to get the bore perfectly true and at right angles with the base of the cylinder casting. If the boring operation has been properly done the cylinder bore can be used to a large extent to true the casting up by. This, however, is a slow operation, especially when it is necessary to move the internal grinding head. To avoid this difficulty, the Reo Motor Car Co. has designed the special fixture shown on the machine in Fig. 20 and in detail in Fig. 21. Inasmuch as there is only 0.005 inch left on the side or 0.010 inch on the diameter of the cylinder bore to be removed by grinding, it is necessary that the bore, which is 10 inches deep, be set practically parallel with the travel of the internal grinding head. Instead of adjusting the internal grinding head casting or slide to suit the position of the cylinder bore when clamped in the jig, the internal grinding head is left stationary and the jig itself is so made that adjustment can be easily and quickly effected. Reference to Fig. 21 will show how this is accomplished.

As a means of locating the cylinder casting in the fixture shown in Fig. 21, four hardened and ground plugs are fitted into the previously drilled and reamed holes in the flange of the cylinder casting *A*. These pins are depended upon to square up the cylinder and it is then held against the face of the fixture by clamping screws *B* and *C*. As the end view shows, clamping screw *C* is held in a stud, the latter acting as a locking member for the swinging lever *D* that holds the clamping screw bearing against the end of the casting.

In operation, the cylinder casting *A* is placed in the fixture and located from the hardened and ground studs previously mentioned. The swinging arm *D* is then moved into position, and screw *B* tightened, after which screw *C* is tightened. The internal grinding wheel is then brought into touch with the bore of the cylinder, and by this means the operator determines whether the casting has been clamped straight or not. If it has not been clamped straight, he re-

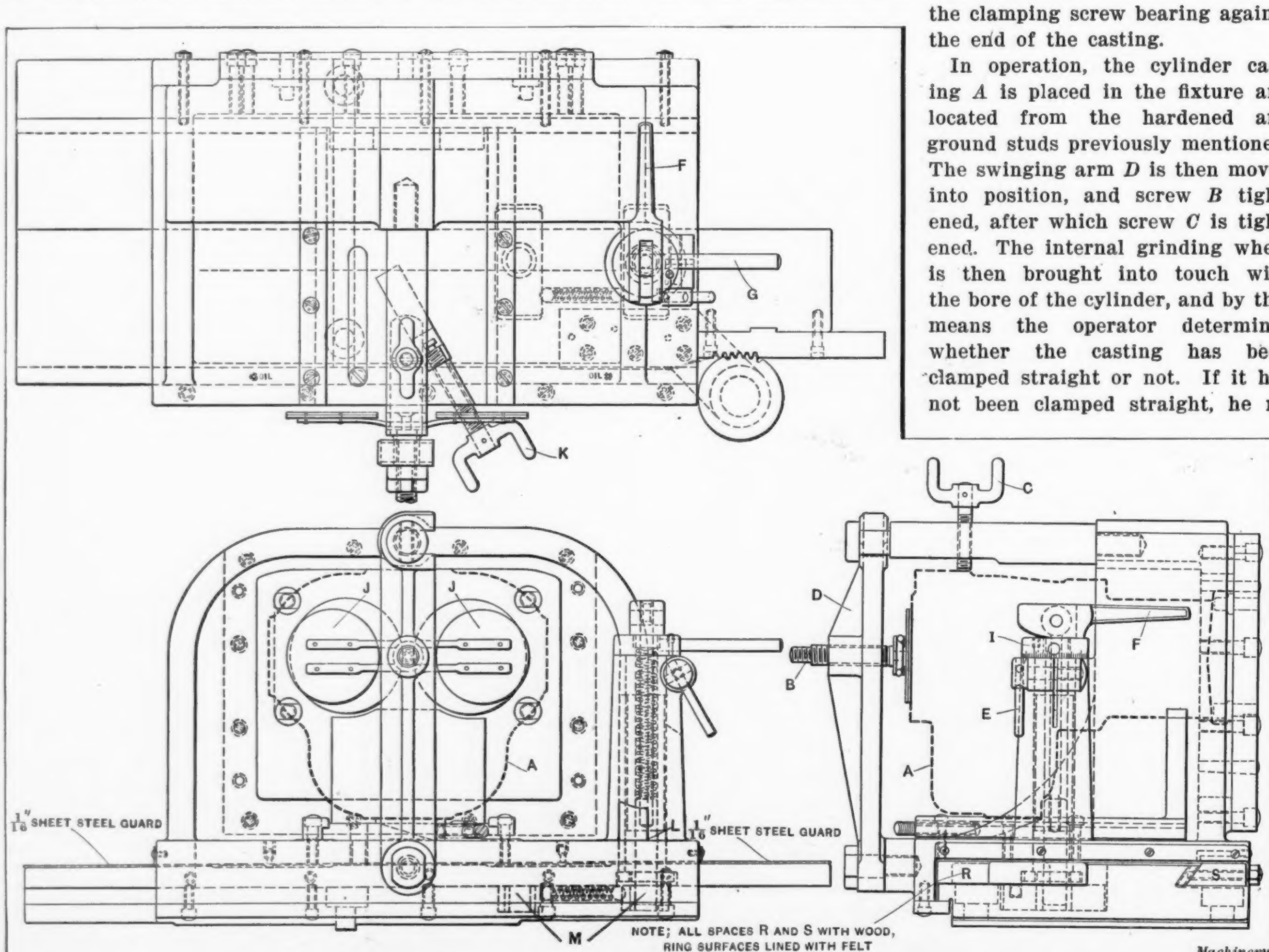


Fig. 21. Special Type of Fixture used on Brown & Sharpe Cylinder Grinding Machine shown in Fig. 20

leases clamp *E* and gives a slight movement to lever *G*, this giving a sidewise adjustment to the fixture carrying the cylinder casting. The collar *I* on top of the stud is graduated in thousandths of an inch so that an operator can tell just how much he has moved the cylinder, and this enables him to set it in position quickly and with great exactitude. After one cylinder bore has been ground, handle *F* is raised, which withdraws plunger *L* from index hole *M*. Handle *H* is then swung, which, by means of a pinion and rack, shifts the fixture on the cross-slide to the other cylinder bore. Lever *F* is then pulled down, inserting plunger *L* into index hole *M* corresponding with the bore to be ground.

For vertical adjustment the screw *K* is operated. This, as shown in the plan view at the top of the illustration, operates an adjustable gib which elevates or lowers the cylinder casting as requirements demand. By these two adjustments it is possible to set the cylinder bore perfectly parallel with the travel of the internal grinding head in a very short space of time and thus remove approximately the same amount of material from all sides of the bore. The fixture is well guarded against dirt by means of wooden strips and felt, the latter being used to line all the circular surfaces. The sliding portion is covered with a 16-inch sheet steel guard. Pads *J* act as connections for the exhaust pipes *L*, Fig. 20. In Fig. 21 the outline of the cylinder is indicated by heavy dotted lines which give a general idea of its position in relation to the other part of the fixture. As an example of the effectiveness of this fixture for the quick grinding of cylinder castings, it might be mentioned that thirty-five cylinder castings are completed in nine hours, that is, seventy cylinder bores are completed in this time, the grinding limit being plus or minus 0.0005 inch, and the hole perfectly true as regards variation in diameter from end to end.

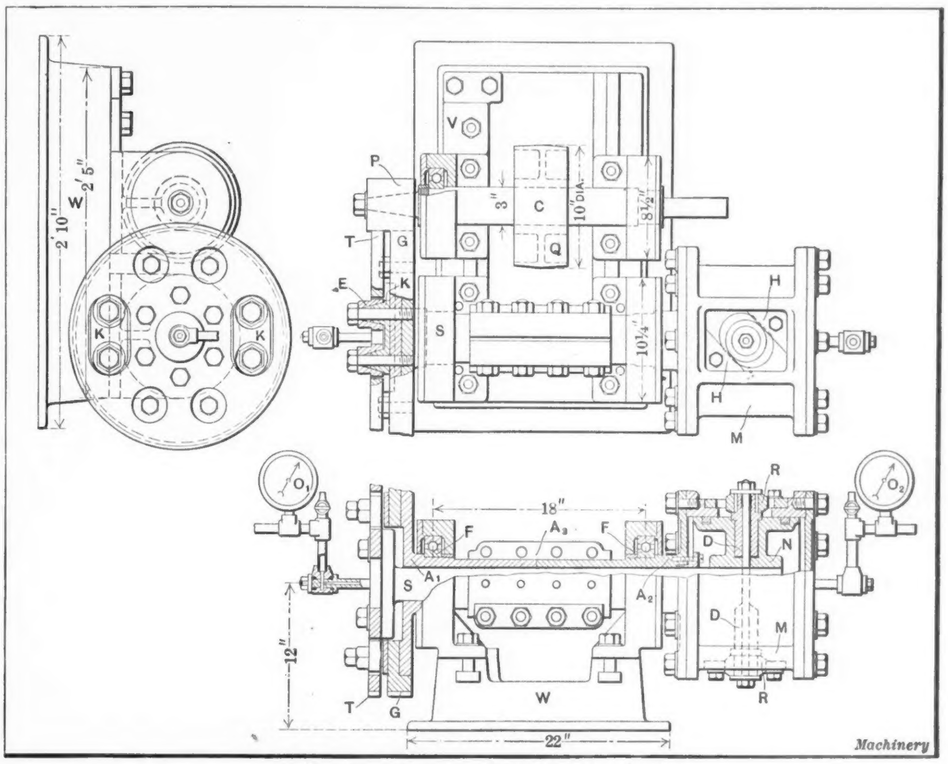
The last and final operation before the cylinders are passed on to the inspection department is the final water test. This is made in the same manner as that which was done prior to machining. This last test is to show up any blow-holes in the casting which might come to the surface after the machining operations have been accomplished, and it also makes sure that a perfect cylinder is turned over to be inspected. The previous examples of fixture design and application are worthy of note. They are especially recommended for the speedy production of cylinder castings with as great accuracy as is demanded by any of the automobile manufacturers now in the business, and no doubt they can be adapted to other classes of work by slight modification. They certainly represent good ideas in fixture design and construction.

* * *

GEAR TESTING MACHINE*

The gear testing machine shown in the accompanying illustration is the result of the writer's efforts to realize in concrete form an ideal machine for the purpose of continuing the experiments reported to the society by Prof. Guido H. Marx at the annual meeting in 1912. The possibility of testing heavier gears at higher speeds with comparatively little power occurred at once to Ralph E. Flanders and to the writer, as pointed out in their discussions of the paper, but the problem remained to design a suitable machine which might also be used to supplement the experiments made by the Committee on Standards for Involute Gears, to determine the friction losses and the running qualities of various types of gearing. After making a number of preliminary sketches the writer was about to put them in the hands of a draftsman, when he had the good fortune to meet Prof. E. P. Lesley, one of Prof. Marx's associates, who accepted the task of preparing the working drawing. The machine as it now appears is due in large measure to his careful attention and skill in the perfection of every detail, and the writer is pleased to acknowledge many helpful suggestions which have broadened the scope of the undertaking and made the design a practical possibility.

The machine proposed is based essentially upon the principle of the machine used in testing by the Committee on Involute Gears, which is to put the teeth under a working load without consuming an excessive amount of power. The design, however, has been modified to facilitate changes



Machine for testing the Strength of Gear Teeth

in the working load and in the test gears employed. At the suggestion of Prof. Lesley, it has also become possible, not only to change the amount of the working load while running, but also to change its direction, thus producing the effect of reversing loads upon the teeth while running continuously in the same direction.

The apparatus has a hollow shaft made in two parts, A_1 and A_2, united by a clamp A_3, also made in two parts to facilitate assembling. At one end of this hollow shaft is a flange to receive the steel gear ring *G*, which serves as a permanent part of the apparatus and is strong enough to resist the stresses due to testing. Besides the hollow shaft *A*, there are two solid shafts *C* and *S* on which are mounted the gears or pinions to be tested. Shaft *S* passes through hollow shaft *A* and has a flange, at one end of which is mounted test gear *T*. Shaft *C*, parallel with shafts *A* and *S*, carries the wide-faced pinion *P*, which is in mesh with both the permanent gear ring *G* and the test gear *T*.

Shafts *A* and *S* are connected at their opposite ends by a novel device through which any desired amount of load in either direction can be applied to the teeth, whether at rest or while running in either direction. To accomplish this purpose, the hollow shaft *A* is flanged to receive the pneumatic cylinder *M*, in which is the piston *N*, firmly secured to the shaft *S*. Pins *D* are driven into the piston *N* through the openings in the cylinder *M*, and upon the projecting ends of these pins rollers *R* are mounted upon roller bearings. A bolt passing through the pins, piston and shaft secures the whole in place. These rollers *R* engage helical segments *H* let into the walls of the cylinder *M*. Air pressure can be applied

* Paper by Mr. Wilfred Lewis, read before the American Society of Mechanical Engineers at New Haven, Conn., November 21, 1913.

to the piston N on either side to give a slight amount of end motion to the shaft S and so, through the action of the rollers upon the helical segments, a slight angular motion is produced between shafts A and S, resulting in a pressure between the teeth of the gears upon these shafts and the teeth of the pinion on shaft C. Pressure gages O_1 and O_2 connecting with each side of the piston area are calibrated to record the resulting pressure on the gear teeth, taking account of the piston areas, the pitch of the helical cams H and the diameter of the gear wheels.

Since but little power is required to drive the apparatus, the pinion P is simply clamped to the shaft C, by a nut on its tapered end. The shaft itself is made heavy for the sake of stiffness and a pulley Q, between bearings, is attached for driving from a countershaft, or if preferred, a motor drive may be used in connection with the extended end. When the gear wheel T is to be tested, the intention is to use it in connection with a steel pinion; and when the pinion P is to be tested, the intention is to make it of cast iron and cut down the width of the teeth engaging with T, by nicking down on either side to a smaller width of face.

When a tooth breaks in the wheel T, or in the pinion P, it is important, to avoid the complete destruction of the apparatus by the jamming of the remaining teeth on their ends, to maintain the wheels G and T in proper relation to each other, and for this reason, the stops K, with their adjustable eccentrics E, are employed. The block K is clamped to the wheel G through the intervening eccentric bushings E. The intention is to keep one of the clamping bolts tight while the other is loosened and the eccentric adjusted to a predetermined amount of clearance on either side, after which both eccentrics are to be clamped. These stops do not come into action unless a tooth is broken or deformed. Then they cause both gears, G and T, to run together. By means of these stops it is also possible to study the effect of a predetermined irregularity in forming or spacing the teeth. For instance, an abnormally wide space or tooth can be simulated, when broken out or purposely cut away, by the position of the stops, and the pounding effect in running will be evident as the result of a certain measured irregularity.

The shafts A and C are mounted in ball bearings to reduce friction and, as a matter of expediency, the scale of the apparatus has been determined by the bearings F on the shaft A. These are of the largest commercial size and to make them available the shaft A was cut in two and united by the clamp A_2. The bearings for the hollow shaft are firmly bolted and doweled to a bed-plate W, while those for the pinion shaft are adjustable to the diameter of the pinion used, a distance piece V of proper width being used in every case to prevent movement under load.

It will be seen that the apparatus is capable of determining to a nice degree of accuracy a number of unsettled problems of great practical importance at a very small expenditure for wear and tear and power. Jigs will be made for drilling the gears G and T after cutting the teeth, so that the relative positions of the two wheels may be accurately fixed. Friction is practically eliminated in the ball and roller bearings, and what remains must become inappreciable under the well-known influence of vibration when running, except that due to air resistance and the friction in the teeth. With some accurate means for measuring the power consumed, both of these variables can be determined better than ever before. The apparatus in skillful hands should therefore solve the mooted question of the effect of speed on strength, and questions of durability, wear and noise can be studied at a small outlay in power and materials. It is possible that some slight modifications may finally be embodied, but the machine as shown is believed to contain the elements needed for an exhaustive examination of the subject of gearing.

* * *

The Eiffel Tower, the highest structure in the world, having a height of about 1000 feet, was only a few years ago regarded as practically useless. Now it is considered one of the most valuable possessions of France. It has made Paris the center of wireless telegraphy, because the tower has the greatest range of any existing wireless telegraph station.

TESTS OF LUBRICATING OILS FOR TRACTION ENGINE MOTORS

The Emerson-Brantingham Co. recently made a series of tests to determine what one or class of oils should be used in the motor of the traction engine built by this company. The motor used in the test was a four-cycle stock motor having four five-inch cylinders, a seven-inch stroke and designed for light tractor purposes. The actual testing period for each oil varied from 9 to 10¾ hours, and was divided into three main parts, *viz.*, the cold test or cold friction test, the power test and the hot test or hot friction test. Part 1 of these tests consisted in measuring the friction horsepower of the motor, when using the new, and also the unused oil. Part 2 was a five-hour continuous power run with a wide-open throttle and maximum load. Five hours was chosen as the length of time for the power test because it was estimated that when the motor ran under full load for five hours continuously, the oil had been subjected to the same amount of work as in an ordinary day's run in the field. During the third part of the test, the cooling water was allowed to heat up to about 210 degrees F. At this point, the ignition and fuel were cut off and the motor was immediately switched over and driven by the Diehl electric dynamometer. Friction and temperature readings were then taken. This part of the test was really the most important as it showed the differences in the lubricating value of the various oils after they had been used in the motor and subjected to heat. In this way the stability and lasting qualities of the oil were determined.

At the end of the third test the oil leakage and consumption was measured and a pint sample of the used oil was taken for analysis. The motor was then put through the cleaning process in preparation for the next oil. Twelve different oils were used in these tests, some of them being "straight run," some compounded and several especially made up for the test by refiners. Physical analysis of the oil which proved much superior to any of the others showed the following properties before use: specific gravity at 60 degrees F. (Baumé), 30.8; viscosity at 70 degrees F. (Tagliabue), 160; viscosity at 210 degrees F., 74; flash point, degrees F., 397; fire point, degrees F., 440; cold flow, degrees F., 0; chill point, degrees F., 27; animal or vegetable matter, none; per cent of free acid, none; per cent of fixed carbon, 1; per cent of ash, none.

After use this oil had changed as follows: specific gravity at 60 degrees F. (Baumé), 30.8; viscosity at 70 degrees F., 140; viscosity at 210 degrees F., 73; flash point, 284 degrees F.; fire point, 388 degrees F.; cold flow, 0; chill point, 0; animal or vegetable matter, none. Per cent of free acid, none; per cent of fixed carbon, 1.2; per cent of ash, 0.01. All of these tests were run at a speed of 700 revolutions per minute (the rated speed of the motor) but nothing was determined as to what results would have been obtained with a higher or lower speed.

* * *

EXTENSIVE INSTALLATION OF AUTOMATIC SIGNALS ON P. R. R.

When the improvements in its automatic block signal system are completed September 1, the Pennsylvania Railroad will have more four-track lines operated under automatic signals than any railroad in the world. During the past three years, $6,000,000 has been expended in equipping 253 miles of the main line with automatic signals. The main line of the Pennsylvania Railroad between Pittsburg and New York and Philadelphia and Washington will be equipped with automatic block signals when work now under way is completed. The signal system east of Pittsburg and Erie represents an estimated investment of approximately $18,000,000. The electro-pneumatic interlocking switch and signal system in the New York station and on the electric line between Sunnyside Yard, L. I., and Manhattan Transfer, N. J., alone cost $1,750,000. A normal force of 1800 men is required to maintain the total signal system of the Pennsylvania Railroad, and the cost of maintenance is about $1,500,000 yearly.

INDEXING TOOLS FOR NOTCHING ARMATURE AND FIELD DISKS

WAYS AND MEANS USED IN THE GENERAL ELECTRIC CO.'S ARMATURE NOTCHING DEPARTMENT IN THEIR FACTORY AT LYNN, MASS.

BY CHESTER L. LUCAS

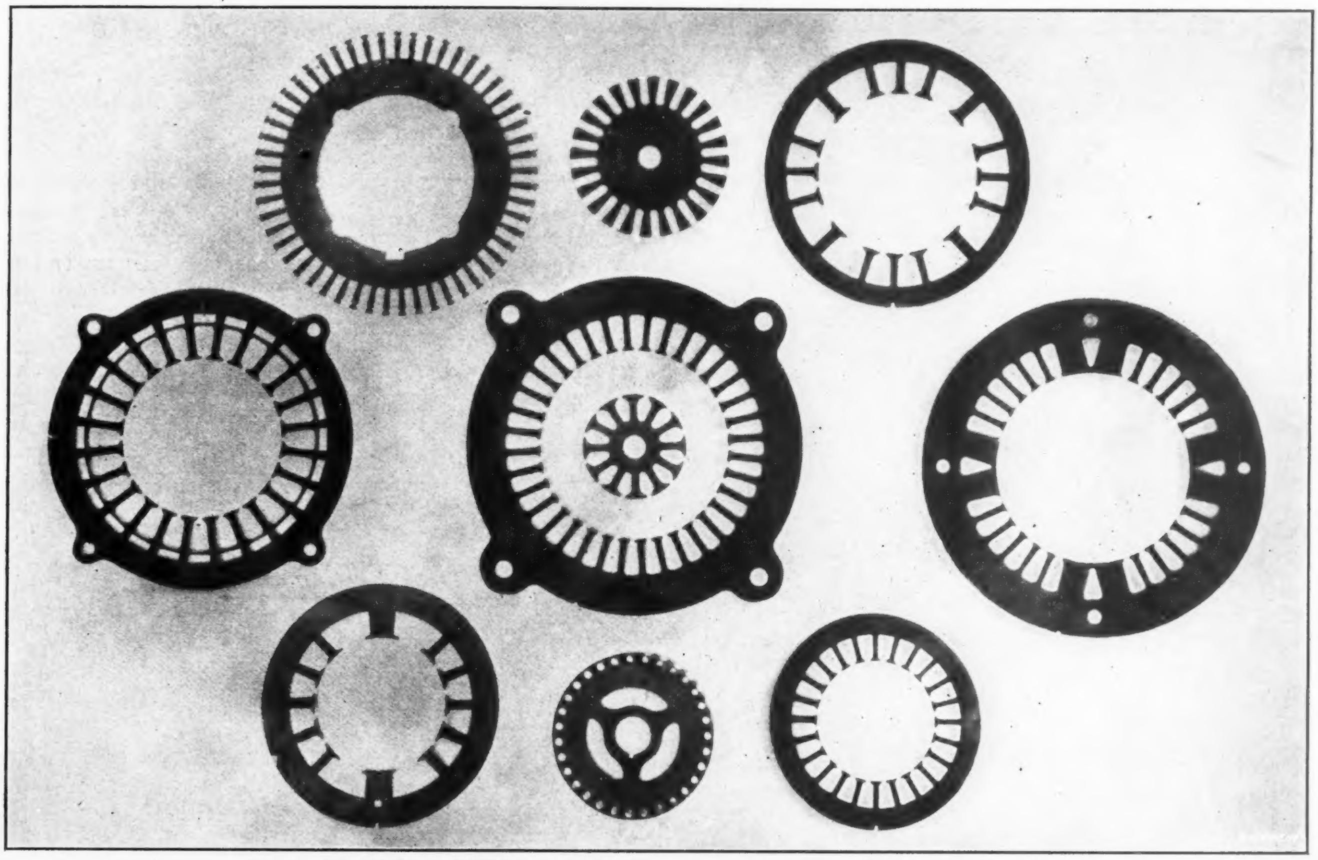


Fig. 1. Representative Armature and Field Punchings of the General Electric Co.'s Lynn Plant

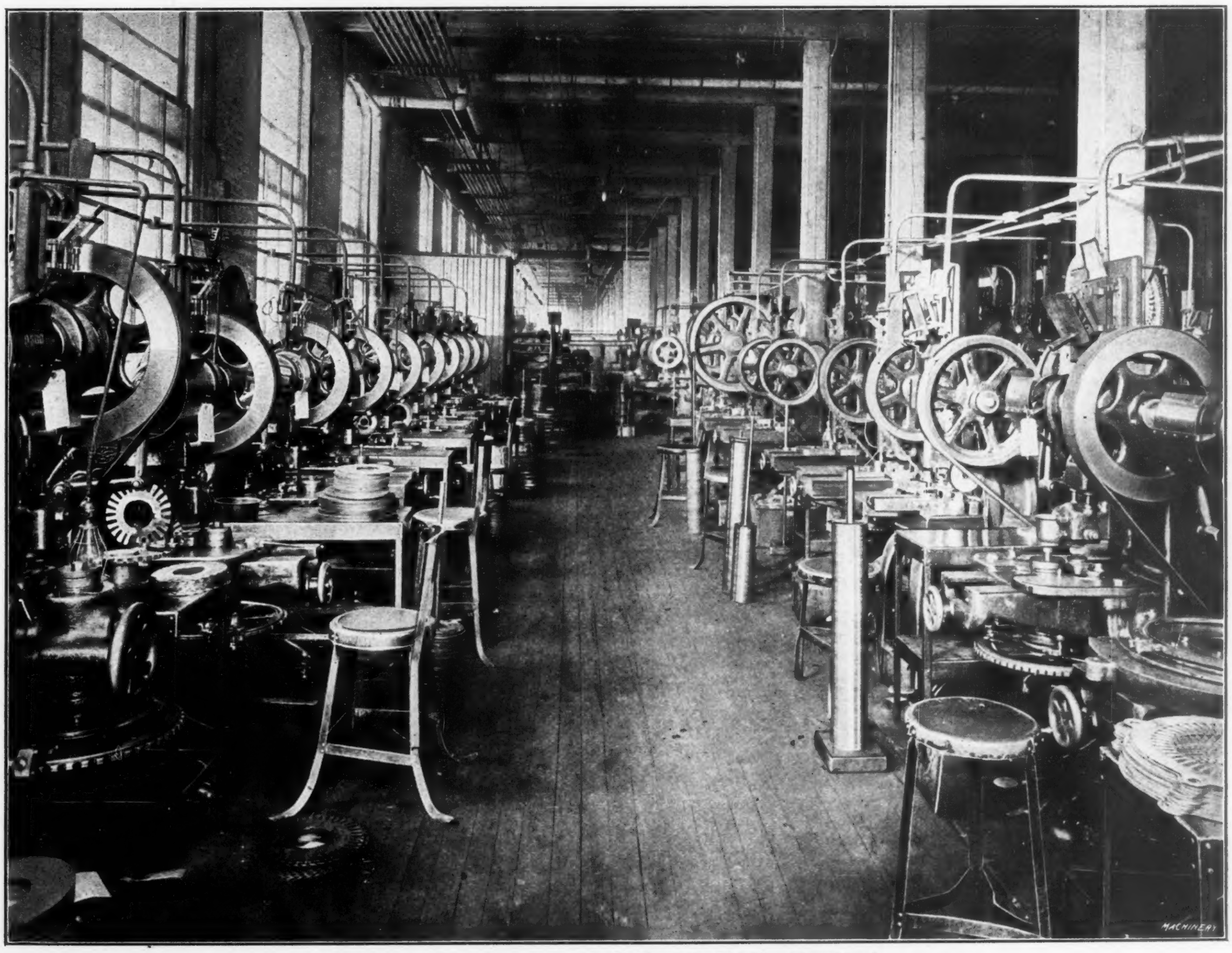


Fig. 2. View down one of the Aisles of the Notching Department

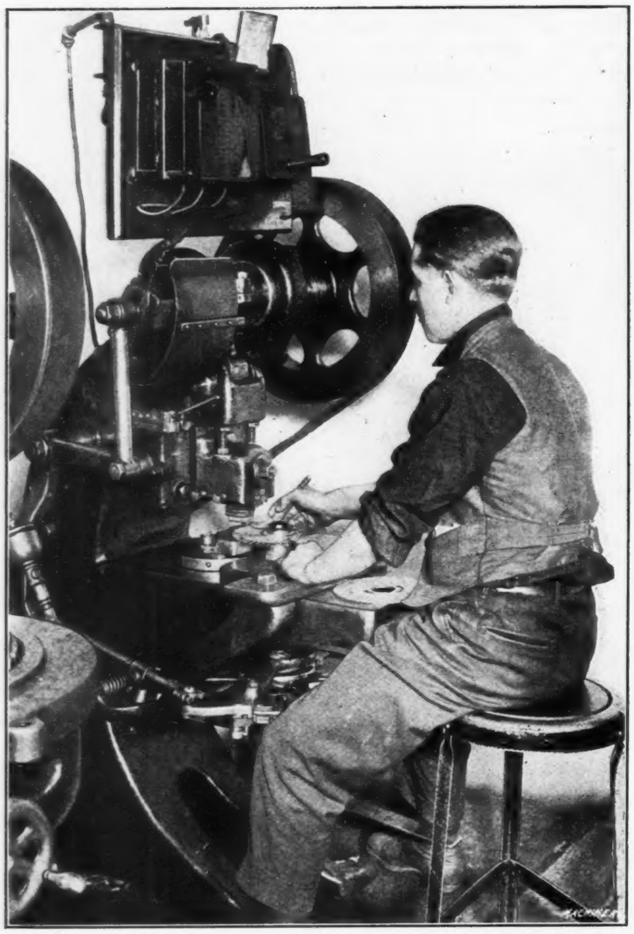


Fig. 3. Notching an Armature Disk by the Use of Indexing Tools

THE punching of the winding slots in the sheet iron disks that compose armature and fields of electric motors, is an important branch of the presswork in an electrical factory. At the Lynn Works of the General Electric Co. this work has been developed to a high degree, and an account of the presses and the work which they do, as well as processes followed in making the tools, should prove of interest. In this article only the single type of notching tools will be considered, as the compound tools are of a different order and should, therefore, be treated separately.

The ideal way of notching armature and field disks is by means of compound dies, for not only is the work of a better quality, but the manufacturing cost is naturally much less. As, however, the cost of a set of compound armature notching tools runs into the hundreds of dollars, there are many instances in which it is the better plan to make tools of the single type, and index the armature sheet by means of an automatic notching press. If there is doubt that the design of motor for which the armature disks are being notched is standard, it is, of course, better to use the single type of notching tools than to spend several hundred dollars on a set of compound tools that would be worthless in case of change of design. Similarly, if the production of a given motor is small, it would be injudicious to make a set of compound notching dies for the work. Again, if it is desired to build a new type of motor and just enough disks are wanted at once to build one or two armatures, the single type of notching tools can be built much more quickly to "bridge the gap," while compound tools are being made for the coming production.

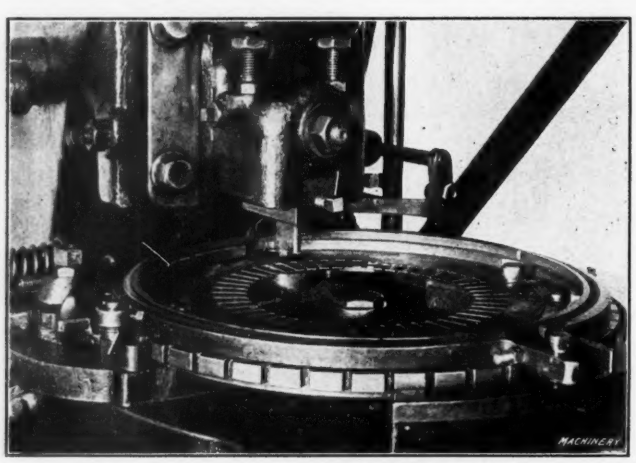


Fig. 4. A Close View of a Field Notching Operation

While the armature disks and field disks are the two general types of sheets to be notched, there are fifteen hundred varieties of spacings, diameters and shapes of slots. Frequently, armature sheets contain several concentric sets of winding slots of different shapes, and occasionally it is desired to have the windings spaced at irregular intervals around the sheets. While notching tools are usually of the single type, occasionally tools are made for cutting two or more slots at one stroke of the press. From this it will be seen that the subject of single type notching tools is a broad one in itself. Fig. 1 shows a group of armature punchings that gives some idea of the variety of this class of work. At the Lynn plant of the General Electric Co. there are fifty notching presses for this particular work, and a section of the notching press department is shown in Fig. 2. A typical armature notching operation is illustrated in Fig. 3. This shows a notching press being used for cutting armature disks, with the operator in the correct position, lubricating the blank as it rotates. The close-range view of the field punching operation in Fig. 4 illustrates the manner in which the tools are used when on field work. Briefly, the operation is a simple piece of press-work, the work being indexed automatically between the punch strokes. In this view the punch and die show very clearly above and below the field punching.

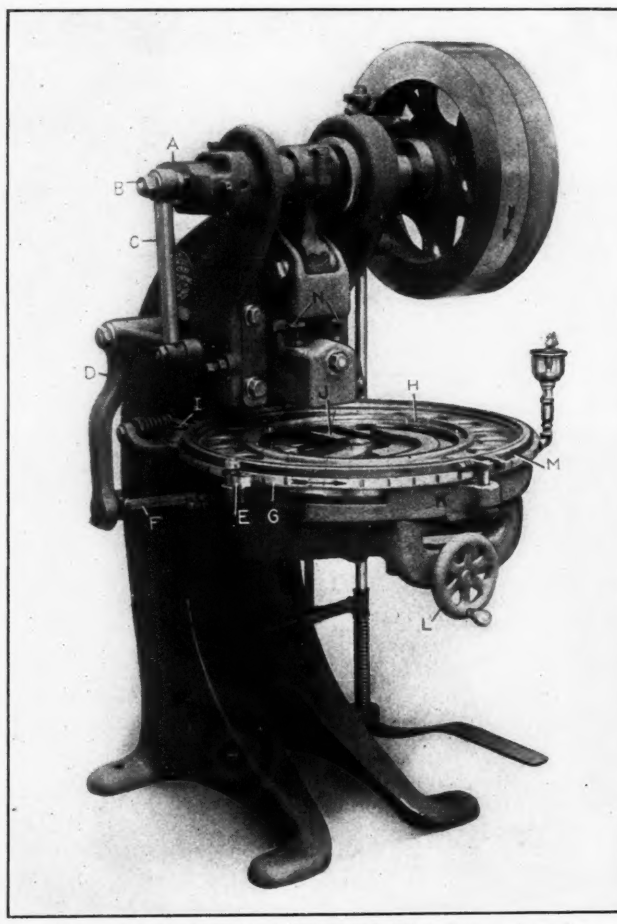


Fig. 5. Front View of a Ferracute Notching Press set up for Field Punchings

Presses for Armature Notching

The presses used for cutting the slots in armature disks are of special design, although they resemble in general the ordinary type of punch press. The distinguishing feature is the mechanism for indexing the armature or field disk, as the case may be, while the punching is taking place. The press has the ordinary reciprocating ram, and, in addition,

the work-holding device is of a type that permits it to be adjusted with reference to the punch. This provides for the notching of sheets of different diameters. While most of the press manufacturers make notching presses, we have selected the Ferracute C-82 press as representative. As shown in Figs. 5 and 6, the press is set up for notching field punchings exclusively. When working on armature disks, the set-up of the indexing mechanism is quite different, as will be described later. The mechanism for indexing the sheet is operated from the left-hand end of the crankshaft. Here there is a slotted arm *A* in which stud *B* may be positioned with relation to the center of the crankshaft. This distance, of course, governs the length of stroke that pitman *C* makes. Pitman *C*, in turn, operates a bellcrank *D*, from which motion is transmitted to pawl *E* through rod *F*. At the end of rod *F* adjustment may be made for varying the position of the stroke with relation to the index-wheel *G*. Supported within index-ring *G*, is the work-holder *H*. At the rear is a locking device for holding the index-wheel and work stationary while the punch stroke is made. This locking mechanism is indicated at *I*. The die-holder is shown at *J* and is supported separately from the blank-holder and index-ring. These latter parts are on a separate carriage *K* that may be moved forward or backward by means of hand-wheel *L*. This, of course, is for varying the distance at

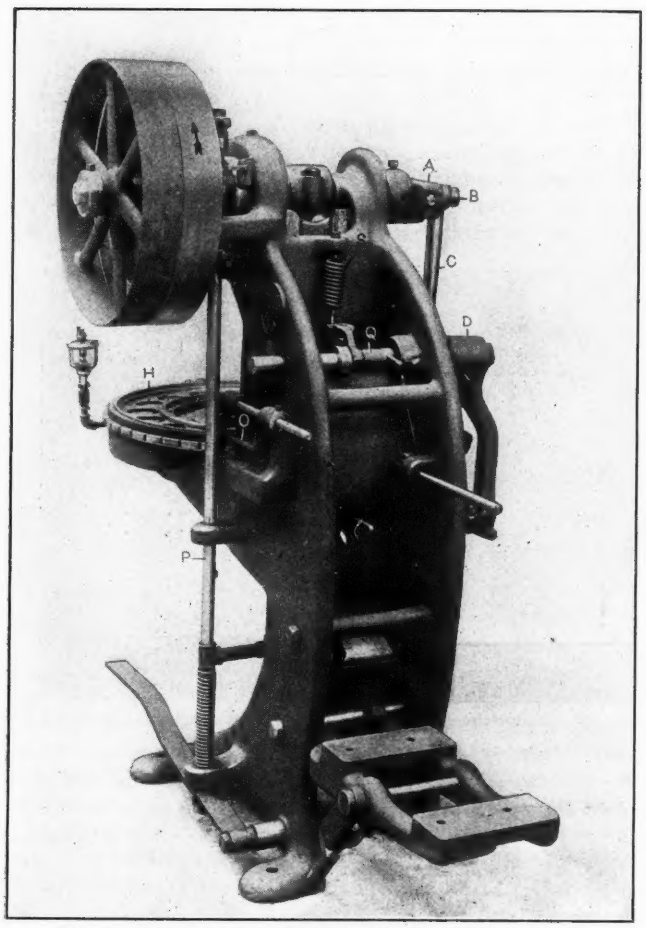


Fig. 6. Rear View of a Ferracute Notching Press set up for Field Punchings

which the punching is done from the center of the work. The difference in location of the indexing mechanism when working at different points on the slide is compensated for by the adjustment of rod *F*. Just above the index-ring is a brake *M* whose function it is to take up the inertia of the revolving disk.

The punch is held in the ram of the press in the usual manner and the adjustment screws *N* govern the position of the ram. The length of the stroke is constant. Now, referring to Fig. 6, which shows the machine from the rear, the method of keeping the press in continuous operation for punching all of the slots in one field punching of the treadle lock may be seen. When the treadle is depressed, treadle lock *O* is pushed up and catches upon a pad on treadle rod

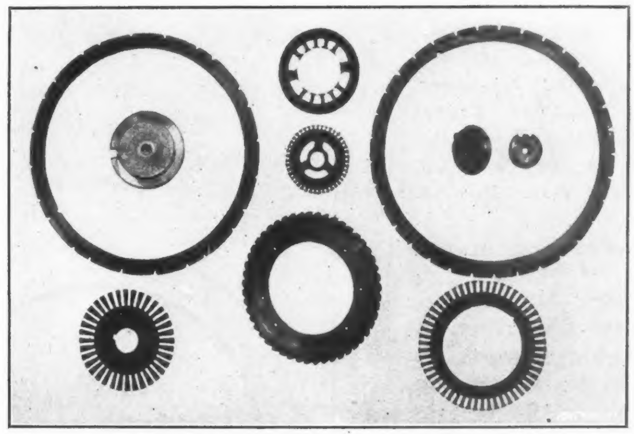


Fig. 7. Index Rings and Center Plugs for Use on Notching Presses, also Sample Punchings

P. A branch connection of the treadle rod extends up within the press and starts the indexing mechanism. Indexing and punching continues until a trigger on the work-holding disk *H* comes around, strikes the treadle lock and allows the clutch to slip, thus stopping the press. Also in this view may be seen the mechanism that operates the lock for holding the disk between indexings while being notched. Each time the ram ascends a projection engages and rocks bellcrank *Q* which, in turn, disengages the dial lock through the rods shown and allows the pawl *E* to move the dial into the proper position for the next slot. The spring *S* is attached to the ram and acts as a counterbalance.

By changing the bed on Ferracute notching presses, they may be set up for external as well as internal work, the external work being done on the armature disks. The view Fig. 3 illustrates the notching of armature disks, and from this it will be seen that the indexing mechanism is, in this case, beneath the bed of the press. The general principles, however, are the same as in field disk notching, although, of course, in armature disk notching the work is held on a central shaft, rather than by a hollow ring.

The operation of a notching press is as follows: The fly-wheel rotates toward the operator, as in other presses, and this causes pitman *C* to descend once in each revolution. This downward movement of the pitman causes bellcrank *D* to operate, which through rod *F* operates pawl *E*. This has been carefully set so that it advances dial *C* and consequently the work which is held in the blank-holder *H* in a counterclockwise direction. The punching is done while the indexing mechanism is on the return stroke and while the punching is going on, the disk is, of course, locked firmly in a stationary position. One depressing of the treadle starts the indexing and notching of a disk and this motion continues until the trigger on the blank-holder comes around and strikes the treadle lock, thus releasing it and causing the press to stop. The operator, as shown in Fig. 3, covers the sheet with a thin film of soda water so as to lubricate the punch. Armature notching presses, generally, run at speeds of from 200 to 450 revolutions per minute. The average speed of the presses at the General Electric Co.'s Lynn factory is 225 revolutions per minute, and the maximum speed employed there is 280 revolutions per minute. The field

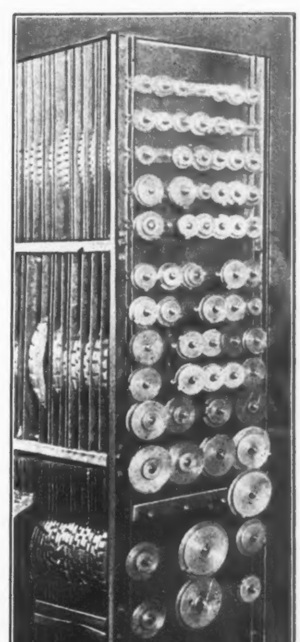


Fig. 8. A Group of Center Plugs and Index Rings

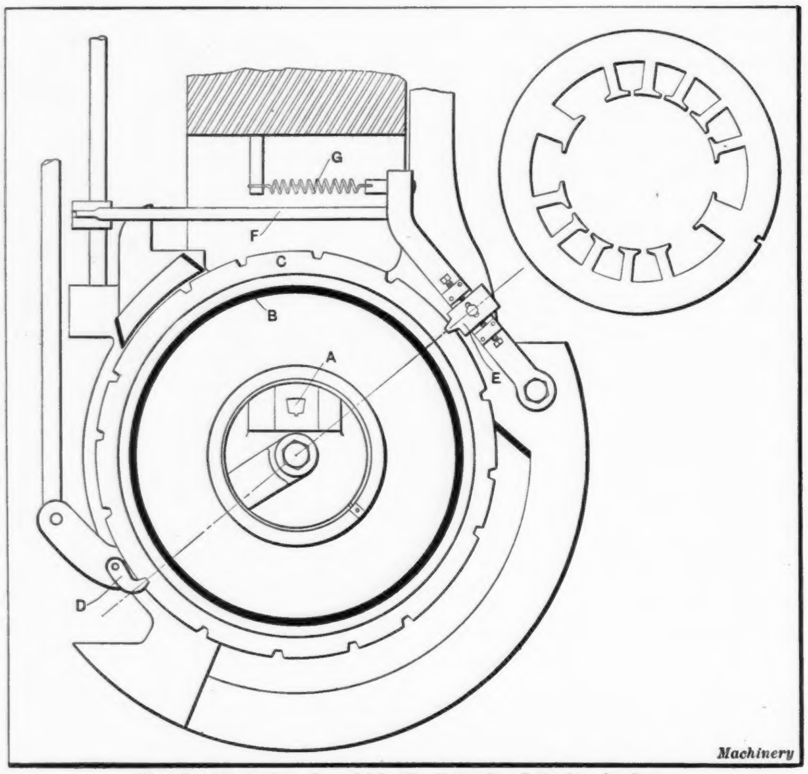


Fig. 9. Mechanism by which the Irregular Indexing is done

punchings are held in the work-holder by means of studs that engage holes in the edges. The armature punchings are held on the driving shaft by a center plug with a key.

Variation in the Spacing of the Slots

Owing to the great variety of specifications to which motors are made, the shapes and spacing of the slots in the armature and field punchings are of great variety. Each number of slots means a separate index-ring. Fig. 7 shows three of the different index-rings used for spacing. In the centers of the two large rings may be seen three center plugs which are used for holding armature disks while notching. Each armature punching having a different size of center hole requires a different size driving plug. The blanks, of course, must fit snugly on these plugs in order to secure accurate spacing. In Fig. 8 is shown a large rack of plugs and index-rings. This gives some idea of the number of rings and plugs necessary to do the large variety of notching required on armature and field punchings.

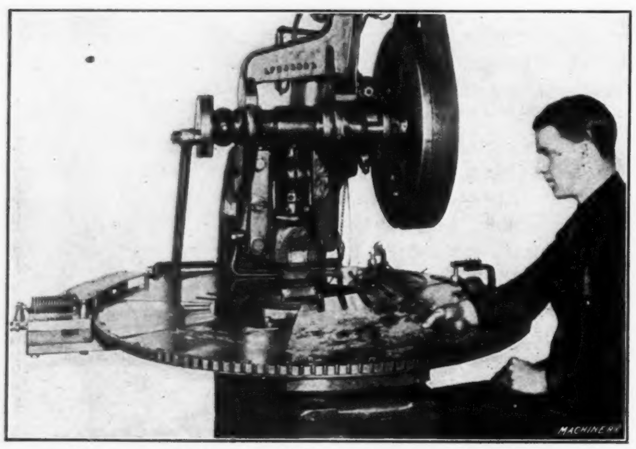


Fig. 10. Notching Operation on Turbine Field Segments

Referring again to Fig. 7, it will be noted that the indexring on the left is notched irregularly and this is for the purpose of spacing the slots at irregular distances around a field punching like that shown in the center of this illustration. In order to space the slots irregularly in these disks, the indexing mechanism must be changed slightly. In Fig. 9 is shown an irregularly spaced field punching and the mechanism for indexing this work. In this will be seen the die at *A*, the blank-holder at *B* and the index-ring at *C*. The index pawl is shown at *D* in the usual position, but the lock has been moved from its central part at the rear to a point diametrically opposite the indexing pawl. This is shown at *E*. The stroke of the indexing pawl is made long enough to cover the longest distance between slots. As soon as the lock *E* is clear of the indexing notch, pressure from eccentric *F* is released and spring *G* draws the lock back against the index-ring, ready to snap into the slot when it comes around. The excess motion in the case of the closely spaced slots is taken care of by allowing the index finger to slip. This method of indexing irregularly could not be used if the slots were not regularly spaced opposite each other.

Special Notching Work

In addition to the regular armature and field notching operations at this factory, there are special notching operations which are of interest. One of these is the turbine armature notching press shown in Fig. 10. These turbine disks are made up of sections, and in order to notch them they are fitted into a special work-holder in succession, and as they feed around under the die, the notches are cut. The operator sits as shown, taking the punched segments from the holder and substituting blanks. When notched in this way, the assembled segments serve as well as entire sheets, and at the same time this method is a more economical way of producing them.

The special notching job shown in Fig. 11 is also of interest in that, in addition to cutting slots, the partly severed part is bent down under the sheet. One of these sheets is shown beside the press. The blank copper sheet is held on the central stud. After each slot is punched and bent down, the die automatically opens endwise and allows the blank to be indexed ready for punching and bending the next slot.

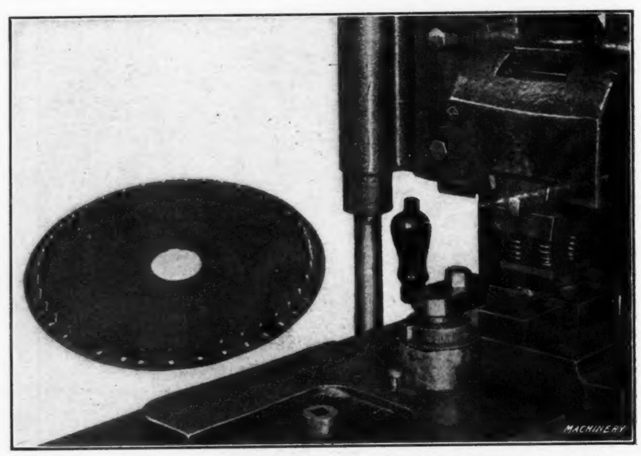


Fig. 11. Continuous Feed Cutting and Bending Notching Operation

In a following number, the making of a set of single type notching dies will be described.

* * *

A number of observations relating to the expansion of steel bridges, due to changes in temperature, are recorded by a writer in the *Engineering News*. It appears from these observations that even under almost ideal conditions of free movement at the bridge bearings, the expansion movement of the bridge does not take place smoothly and continuously, but movements occur on the roller bearings for every three to five degrees F. rise in temperature, these movements being generally accompanied by loud noise due to the sudden displacement of the bridge members.

* * *

A patent has been granted to Mr. H. I. Seddon of Portland, Oregon, which provides an erasing attachment for a typewriting machine. The erasing head is pivoted on a bar and the lever is connected to a key lever, so that it can be operated by a key on the keyboard.

THEORY OF THE STRESSES IN A CURVED BAR AS APPLIED TO HOOK DESIGN

APPLICATION OF A NEWLY DEVELOPED THEORY TO PRACTICAL DESIGNING PROBLEMS

BY WILLIAM L. CATHCART*

IN an article in the June number of MACHINERY, answering a correspondent's question with regard to certain proportions of crane hooks, the writer cited a formula† deduced by Professor Karl Pearson and Mr. E. S. Andrews of University College, London, England, from which can be computed the stresses in a curved bar eccentrically loaded, which is essentially the condition of every hook. Since this formula applies generally to any curved machine member thus loaded—such as the frames of punch presses and riveting machines—it is of fundamental importance in machine design. For this reason the following brief analysis of the properties of the formula, its effects on the design of hooks, and a comparison of the stresses calculated from it with those computed by the straight-bar formula, so long in general use for this purpose, have been prepared.

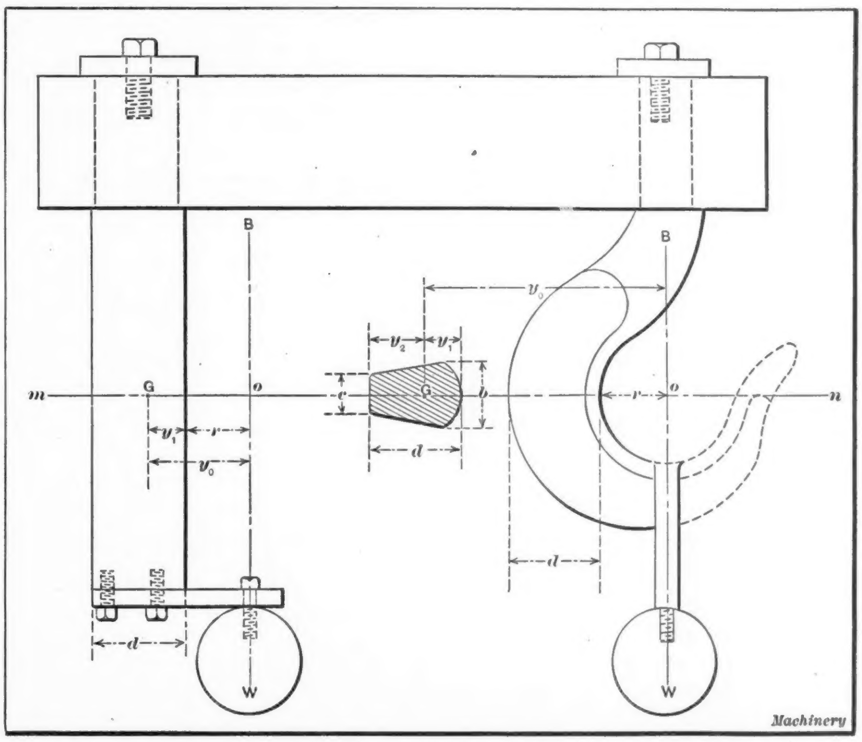


Fig. 1. Diagram showing Condition of Straight and Curved Bars eccentrically loaded

Fig. 1 shows the conditions in the two cases. Let two bars—one straight and the other curved, both being of the same trapezoidal section, b, c, d, of area A—be rigidly suspended and loaded at the lower end with the weight W at a distance y_0 from the center of gravity G of the cross-section of each. This section is taken on the line mn through the principal or horizontal section of the curved bar. Since this, as the location of the maximum stress, is the so-called "dangerous section" of a hook, it is the one requiring chief consideration; other proportions below it have less strain but their size must be increased beyond the demands of strength to provide for the effects of wear. The line mn meets the load line BW at the point o. The side of either bar which is nearest to its load is the one at which the maximum stress in the section occurs, this stress being tensile; and the distance of this side from the load line is denoted by r, which is also the radius of opening in the crane hook. The distance of the center of gravity G from the load line is $y_0 = y_1 + r$. Between the sides b and c of the cross-section, the stress changes from tensile to compressive, but the maximum compressive stress at c is always less than the maximum tensile stress at b. Hence the compressive stress need not be considered in determining the elastic limit of the hook. The question then reduces to the difference between the maximum tensile stresses which the same load W, with the same eccentricity y_0, will produce in the two bars.

In the straight-bar formula, the load W has two effects on the bar—pure tension, since the load must be supported; and bending, since the load has the leverage y_0. If f denotes the maximum tensile stress in the bar, *i. e.*, the stress at the middle of the side b of the cross-section, it must evidently be the sum of the stress due to pure tension and that due to bending. Assuming the former stress to be uniformly distributed over the cross-sectional area A of the bar, the general formula for these conditions is:

$$\frac{W}{f} = \frac{A}{1 + \dfrac{y_0 y_1}{R^2}} \qquad (1)$$

where R is the radius of gyration of the area A about an axis passing through its center of gravity G and parallel to the sides b and c. A working formula cannot be derived from this expression unless b and c are given in terms of the depth d. Taking $c = 0.22d = b/3$—which is in accord with good practice—we have for a trapezoidal section:

$A = 0.44\,d^2$

$y_1 = 0.417\,d$

$y_0 = y_1 + r = 0.417\,d + r$

$R^2 = 0.0761\,d^2$

Substituting these values in equation (1) gives:

$$\frac{W}{f} = \frac{d^2}{7.47\,d + 12.454\,r} \qquad (2)$$

Since W and f are known, the value of d for any given value of r can be found from this equation. Various values of d thus found are given in close approximation in A. E. Holcomb's table, quoted in Kent's Pocketbook, 1912, page 1161.

Curved-bar Formula

For the derivation of this formula, the reader is referred to the original investigation of its authors as cited; it is too complex and extensive to receive analytical treatment in this article. Briefly: it considers the curvature of the hook which the straight-bar formula entirely neglects; and it assumes that the centers of curvature of the inner and outer sides of the hook at b and c, respectively, coincide with the center of curvature at the point G in Fig. 1. For a hook, it is also assumed that this center may be taken at the point c without appreciable error. It assumes that only tension and compression act on the section bcd and that shear is absent;

TABLE I. VALUES FOR SUBSTITUTION IN EQUATION (3)

$\frac{y_1}{y_0}$	$\frac{1}{\left(1-\frac{y_1}{y_0}\right)^{\frac{5}{4}}}$	$\frac{y_1}{y_0}$	$\frac{1}{\left(1-\frac{y_1}{y_0}\right)^{\frac{5}{4}}}$
0.30	1.561	0.41	1.934
0.31	1.592	0.42	1.976
0.32	1.620	0.43	2.020
0.33	1.650	0.44	2.066
0.34	1.683	0.45	2.114
0.35	1.715	0.46	2.164
0.36	1.748	0.47	2.212
0.37	1.782	0.48	2.267
0.38	1.818	0.49	2.325
0.39	1.855	0.50	2.380
0.40	1.893	....	.....

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* Address: Gwynedd Valley, Pa.

† "A Theory of the Stresses in Crane and Coupling Hooks with Experimental Comparisons with Existing Theory." Dulau & Co., London, England.

TABLE II. COMPARISON OF STRESSES GIVEN BY STRAIGHT-BAR AND CURVED-BAR FORMULAS

Load and Radius of Opening of Hook	Dimensions	Designed Maximum Tensile Stress f, Pounds per Square Inch		
		12,000	18,000	24,000
20,000 pounds $r = 2\frac{3}{4}$ inches	d	$4\frac{7}{8}$	$4\frac{3}{16}$	$3\frac{3}{4}$
	c	$1\frac{1}{8}$	$\frac{15}{16}$	$\frac{13}{16}$
	b	$3\frac{3}{8}$	$2\frac{13}{16}$	$2\frac{7}{16}$
	b_1	$5\frac{5}{8}$	$4\frac{5}{8}$	$3\frac{7}{8}$
	A	10.97	7.84	6.11
	A_1	15.84	11.11	8.8
	S_t	17,842	25,882	33,811
	S'_t	12,107	18,054	23,844
40,000 pounds $r = 3\frac{1}{2}$ inches	d	$6\frac{3}{4}$	$5\frac{3}{4}$	$5\frac{1}{8}$
	c	$1\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{1}{8}$
	b	$4\frac{1}{2}$	$3\frac{3}{4}$	$3\frac{3}{8}$
	b_1	8	$6\frac{1}{4}$	$5\frac{5}{16}$
	A	20.25	13.37	11.53
	A_1	32.06	21.56	16.49
	S_t	19,908	28,201	35,210
	S'_t	11,943	17,938	24,013
60,000 pounds $r = 4\frac{1}{4}$ inches	d	$8\frac{5}{16}$	$7\frac{1}{16}$	$6\frac{1}{4}$
	c	$1\frac{13}{16}$	$1\frac{9}{16}$	$1\frac{3}{8}$
	b	$5\frac{7}{16}$	$4\frac{11}{16}$	$4\frac{1}{8}$
	b_1	$9\frac{5}{8}$	$7\frac{7}{16}$	$6\frac{7}{16}$
	A	30.12	22.03	17.19
	A_1	47.52	31.77	24.41
	S_t	19,725	27,265	35,877
	S'_t	12,017	18,030	23,990
80,000 pounds $r = 4\frac{5}{8}$ inches	d	$9\frac{5}{8}$	$7\frac{15}{16}$	$7\frac{1}{16}$
	c	$2\frac{1}{16}$	$1\frac{3}{4}$	$1\frac{9}{16}$
	b	$6\frac{3}{16}$	$5\frac{1}{4}$	$4\frac{11}{16}$
	b_1	$11\frac{5}{8}$	$8\frac{11}{16}$	$7\frac{13}{16}$
	A	38.67	27.79	22.06
	A_1	63.00	41.15	33.04
	S_t	20,152	28,497	35,897
	S'_t	12,005	18,021	23,958
100,000 pounds $r = 4\frac{1}{2}$ inches	d	$10\frac{5}{16}$	$8\frac{3}{4}$	$7\frac{3}{4}$
	c	$2\frac{1}{4}$	$1\frac{15}{16}$	$1\frac{11}{16}$
	b	$6\frac{3}{4}$	$5\frac{13}{16}$	$5\frac{1}{16}$
	b_1	$13\frac{5}{16}$	$10\frac{3}{16}$	$8\frac{3}{4}$
	A	46.59	33.91	26.16
	A_1	80.21	53.11	40.45
	S_t	21,862	29,461	38,651
	S'_t	11,946	18,096	23,954

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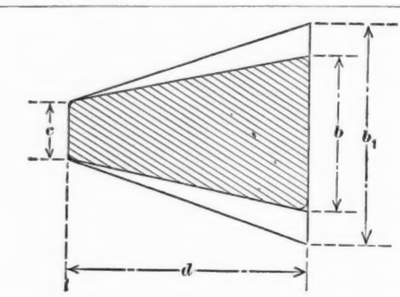

and finally, the formula does not apply beyond the limits at which the stress is proportional to the strain, *i. e.*, broadly speaking, beyond the elastic limit. While there is a true neutral axis in the section, the stresses given by the formula do not vary simply as their distance from that axis, as in a straight bar, and the stress due to pure tension is not distributed uniformly over the cross-section, but differs in intensity at various points, being a maximum at the middle of the side *b*. This latter point is of primary importance. The formula, as applied to crane hook sections, is:

$$S_t = \frac{W}{A}\left\{\frac{1}{F_2}\left[\frac{1}{\left(1-\frac{y_1}{y_o}\right)^{\frac{5}{4}}}-F_1\right]+1\right\} \quad (3)$$

where S_t = tensile stress, in pounds per square inch, at point of maximum stress (middle of side *b*) in the cross-section;

W = load on hook, in pounds;

A = area of cross-section of hook at middle section of depth *d*, in square inches;

y_1 = distance from center of gravity *G* of cross-section to point of maximum stress, in inches;

$y_o = y_1 + r$, in which *r* is the radius of opening of the hook, in inches;

R = radius of gyration of cross-section about an axis passing through center of gravity *G* and parallel to the sides *b* and *c*;

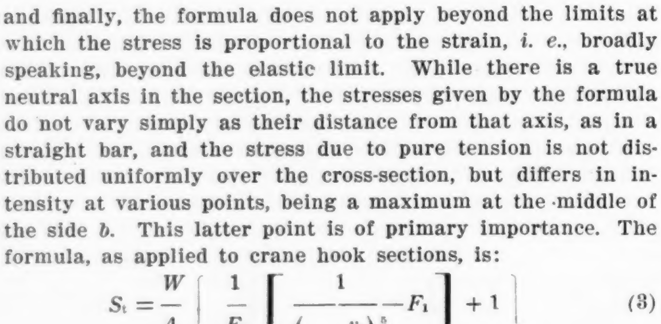

Fig. 2. Condition of a Shear Frame under Load

F_2 = a function whose value, for hook sections, may be taken as $\frac{Ry_1}{1.2y_o^2}$;

F_1 = a function whose value, for hook sections, may be taken as $1 + 1.1F_2$.

As noted in the previous article, the values of F_1 and F_2 apply to hook sections only, and are merely approximate. They are, however, sufficiently close for the general comparison of stresses given in Table II. In applying Formula (3) to a curved member considered as a bent beam, such as the frames of punching, riveting and shearing machines, the fraction $1/F_2$ is replaced by l/R_1F_2. As shown in Fig. 2, *l* is the distance from the load-line of the machine to the center of gravity *G* of the cross-section *ab* which is under the greatest strain, and R_1 is the radius of curvature of the cross-section at the point *G*. The radius of curvature is, in this case, simply the radius of the arc passing through the centers of gravity of several cross-sections very close to that at *ab*. The functions F_1 and F_2 would, of course, have values depending on the section and shape of the member and differing from those given above. In hook sections, *l* and R_1 may each be taken as equal to y_o, and hence the fraction l/R_1F_2 reduces to $1/F_2$. While Formula (3) is apparently complex, its solution for any given case involves only simple though somewhat tedious algebraic processes; and the data of Table I will facilitate the work. An example is given below.

Examples and Applications

Example 1: Take the hook given in Table II with load $W = 60,000$ pounds, radius *r* of opening $= 4\frac{1}{4}$ inches, and maximum stress *f* given by the straight-bar formula as 18,000 pounds per square inch. Assuming $c = 0.22d = b/3$, we have by Equation (2), $d = 7\frac{1}{16}$ inches, $c = 1\frac{9}{16}$ inches and $b = 4\frac{11}{16}$ inches. Then:

$$A = d \times \tfrac{1}{2}\ (b + c) = 22.03 \text{ square inches.}$$

$$W/A = 60,000/22.03 = 2724 \text{ pounds.}$$

$$y_1 = d/3 \times (b + 2c) \div (b + c) = 2.35 \times 1.25 = 2.94 \text{ inches.}$$

$$y_o = y_1 + 2.94 + 4.25 = 7.19 \text{ inches.}$$

$$R = \sqrt{\frac{d^2}{18} \times \frac{b^2 + 4bc + c^2}{b^2 + 2bc + c^2}} = \sqrt{2.77 \times 1.37} = 1.95.$$

$F_2 = Ry_1 \div 1.2\ y_o^2 = 0.092.$
$F_1 = 1 + 1.1\,F_2 = 1.1012.$
$1/F_2 = 1 \div 0.092 = 10.87.$

$y_1/y_o = 0.41$ and from Table I $\left(1 - \frac{y_1}{y_o}\right)^{\frac{5}{4}} = 1.934.$

Substituting in Equation (3): $S_t = 2724 \times [10.87 \times (1.934 - 1.1012) + 1] = 27{,}265$ pounds per square inch, as compared with the 18,000 pounds given by the straight-bar formula.

Comparison of the Stresses Derived from the Two Formulas for the General Range of Hook Sections

In Table II there are given the data for hooks of average radius of opening, with loads varying from 20,000 to 100,000 pounds inclusive, and designed for maximum tensile stresses

TABLE III. ANALYSIS OF HOOKS TESTED

Rated Capacity	Load at Elastic Limit, Pounds			
	30-ton, Cast Steel	20-ton, Cast Steel	15-ton, Wrought Iron	10-ton, Wrought Iron
By test..................	56,000	30,000	16,000	16,000
By straight-bar formula ..	115,000	70,000	73,000	26,000
By curved-bar formula....	55,080	29,925	15,000	15,000

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of 12,000, 18,000, and 24,000 pounds per square inch, these stresses being those frequently used for crane hooks of cast steel, wrought iron, and hammered steel, respectively. The stresses computed from the curved-bar formula in two alternative sections for each hook are given in Table II. The stress S_t is the maximum tensile stress in the original section of area A, whose dimensions b, c, and d are derived from the straight-bar Formula (2) on the assumption that $c = 0.22d \doteq b/3$. Hence, for this section, f represents the designed stress by Formula (2) and S_t the actual stress by Formula (3). The stress S'_t is the similar maximum stress in the alternative section of area A_1, in which c and d remain the same and b is increased to b_1 in order to make $S'_t = f$. As the nearest 1/16 inch was taken for all computed dimensions, S'_t is not exactly equal to f. For these sections and their designed maximum stresses, Table II gives an average ratio S_t/f of 1.567, *i. e.*, for a section proportioned by the straight-bar formula, the curved-bar formula will indicate a maximum stress 1.57 times greater than the designed stress. The average ratio b_1/b is 1.686, *i. e.*, to reduce the maximum stress S_t in the area A to the designed stress f, we must make $b_1 = 1.69b$, on the average. This increase gives the average ratio $A_1/A = 1.514$, *i. e.*, in these conditions and for this range of stress and load, the curved-bar formula gives an average area A_1 which is 1.51 times greater than that given by the straight-bar formula.

The values of the three ratios found in the preceding paragraph are not strictly accurate for two reasons: first, the curvature of the hook section shown in Fig. 1 has been disregarded for simplicity, and the section has been treated as a trapezoid; second, all results from Formula (3) depend on the values of the functions F_1 and F_2 and the values we have used are, as stated, merely approximate. The resultant error seems, however, rather to favor the straight-bar formula than otherwise, as the tests* of Prof. Walter Rautenstrauch, given in Table III, indicate. For example, the 30-ton, cast steel crane hook was strained to its elastic limit at the point of maximum tensile stress by a load of 56,000 pounds. The calculated elastic limits of the hook were: by the straight-bar formula, 115,000 pounds; and by the curved-bar formula, 55,080 pounds, which gives a ratio of calculated elastic limits of $115{,}000/55{,}080 = 2.08$, as compared with the average ratio $S_t/f = 1.57$, previously determined. Considered as a straight bar, as in Formula (2), this hook should have withstood a load of 115,000 pounds before yielding at its elastic limit.

Ratio S_t/f as Given by the Two Formulas

Substituting the values of the functions F_1 and F_2 in Formula (3), solving Formula (1) for f, and dividing it into (3), we have:

$$\frac{S_t}{f} = \frac{1.2y_o^2 \times R}{y_1(R^2 + y_oy_1)}\left[\frac{1}{\left(1 - \frac{y_1}{y_o}\right)^{\frac{5}{4}}} - \frac{0.1\,R \times y_1}{1.2\,y_o^2} - 1\right] \quad (4)$$

This is the ratio between the stress given by the curved-bar formula and that for the same cross-section from the straight-bar formula. Formula (4) is not strictly accurate, owing to the approximate values of the functions. These ratios, found from Table II for the range of hooks covered, are given in Table IV.

Example 2: From the data of the previous example, we have $y_1 = 2.94$, $y_o = 7.19$, $1.2\,y_o^2 = 62.04$, $R = 1.95$, $R^2 = 3.8$, and $\frac{1}{\left(1 - \frac{y_1}{y_o}\right)^{\frac{5}{4}}} = 1.93.$

Substituting these values in Formula (4) gives:

$$\frac{S_t}{f} = \frac{120.98}{73.32}(1.93 - 1 - 0.009) = 1.519.$$

Experimental Verification of Curved-bar Theory

In the article published in the June number of MACHINERY, there were cited the tests on crane hooks of Prof. John Goodman† of the University of Leeds and Prof. Walter Rautenstrauch‡ of Columbia University. Both of these investigators found a very close agreement between the elastic limits of the hooks as given by tests and as computed from the curved-bar formula. The divergence from the elastic limit as found by Formula (2) was marked in each of the two series of tests. In the course of their investigation, Prof. Pearson and Mr. Andrews made various tests, the results of which indicated in every case the truth of their theory. But one of these tests need be cited here—that of a coupling hook for a railway car. The principal section of this hook was rectangular with an area of 6 square inches. The old theory gave a stress at the elastic limit of 12,000 pounds per square inch, the new theory a stress of 23,000 pounds. A tensile specimen from an unstrained part of the hook showed later

TABLE IV. VALUES OF RATIO S_t/f

Load and Radius of Opening of Hook	Designed Maximum Tensile Stress f, Pounds per Square Inch			Average Ratios
	12,000	18,000	24,000	
20,000 lbs. $r = 2\frac{3}{4}$ inches..	1.487	1.438	1.409	1.445
40,000 lbs. $r = 3\frac{1}{2}$ inches..	1.659	1.567	1.467	1.564
60,000 lbs. $r = 4\frac{1}{4}$ inches..	1.644	1.515	1.495	1.551
80,000 lbs. $r = 4\frac{3}{8}$ inches..	1.679	1.583	1.496	1.586
100,000 lbs. $r = 4\frac{1}{2}$ inches..	1.822	1.637	1.610	1.690
Average ratios............	1.658	1.548	1.495	1.567

Machinery

an elastic limit of 21,000 pounds. The curved-bar formula was therefore less than 9 per cent in error, as compared with 75 per cent for the straight-bar formula.

Relations of the Curved-bar Theory to Hook Design

The experimental verification of this theory has been sufficiently full to warrant careful consideration of it in the design of the principal section of hooks. Its fundamental principle, the effect of the curvature of the bar on the stresses produced, is not recognized by the straight-bar theory. In Formula (2), the quantity r is—so far as its effect on the stresses produced is concerned—not really a radius, but simply the distance from the load line to the inner side of the principal section. If r, b, c, and d in Fig. 1 be kept the same, hooks of an indefinite number of shapes between the principal section and the load line could be made, and by Formula (2) all should be equally strong, which seems scarcely a rational engineering proposition. As a matter of fact, the straight bar seems to be really a hook of infinite radius, whose stresses have been taken as those of a hook of the same section and of any finite radius which the designer may require. With regard to the curved-bar formula, we note:

* Transactions American Society of Mechanical Engineers, Vol. 31.
† Proceeding of the Institution of Civil Engineers, Vol. 167.
‡ Referred to in a preceding paragraph of this article.

1. According to the general and approximate comparisons given in Table II, it shows a maximum tensile stress which is 1.57 times greater than the straight-bar formula gives as an average, with a corresponding average increase in area to attain the designed stress of 51 per cent. This would indicate, not that hooks designed by Formula (2) are dangerously weak, but that their factors of safety are much reduced and that their principal sections are uneconomical in form.

2. Of course, it is not assumed that the section of area A_1, used for comparison only in Table II, is by any means the most economical. With regard to the most satisfactory form of section from the standpoint of equal maximum tensile and compressive stresses, Prof. Rautenstrauch states: "It has been pointed out by Prof. Pearson that a section with such proportions is approximately an isosceles triangle with a radius of curvature of 1.75 of the height." This statement is confirmed by the fact that Formula (3) gives a maximum compressive stress at the outer side of the section which is much lower than the corresponding stress given by the straight-bar theory. Hence, metal between the center of gravity G of the section and this outer side is not nearly so effective as that between G and the inner side. There are two reasons for this: the metal at the inner side must meet the greatest strain and the greater area should be there; and, second, the more metal there is between the center of gravity G and the inner side, the nearer G will be to that side and hence the less the value of y_1 will be and consequently the leverage of the load.

3. Both the theoretical proportions previously mentioned, for equal maximum tensile and compressive stresses and Formula (5) which follows, show that the curved-bar theory requires hooks whose depth d is less and whose internal width b is considerably greater than those usual in American practice. Thus, taking the hook sections as triangular and the radius of curvature as y_o, we have $y_o = 1.75d$, and, as the center of gravity of a triangle is situated at one-third of the height from the base,

$$y_o = 1.75\,d = r + y_1 = r + 0.33\,d$$

Hence $d = \dfrac{r}{1.42}$.

If, as in Example 1, $r = 4.25$ inches, d would be 3 inches instead of 7.06 inches as given, and b would be much greater in order to secure the necessary area. Again, the curved-bar formula for the maximum compressive stress at the middle of the outer side c is:

$$S_c = \frac{W}{A}\left[\frac{1}{F_2}\left\{F_1 - \frac{1}{\left(1+\dfrac{y_2}{y_o}\right)^2}\right\} - 1\right] \qquad (5)$$

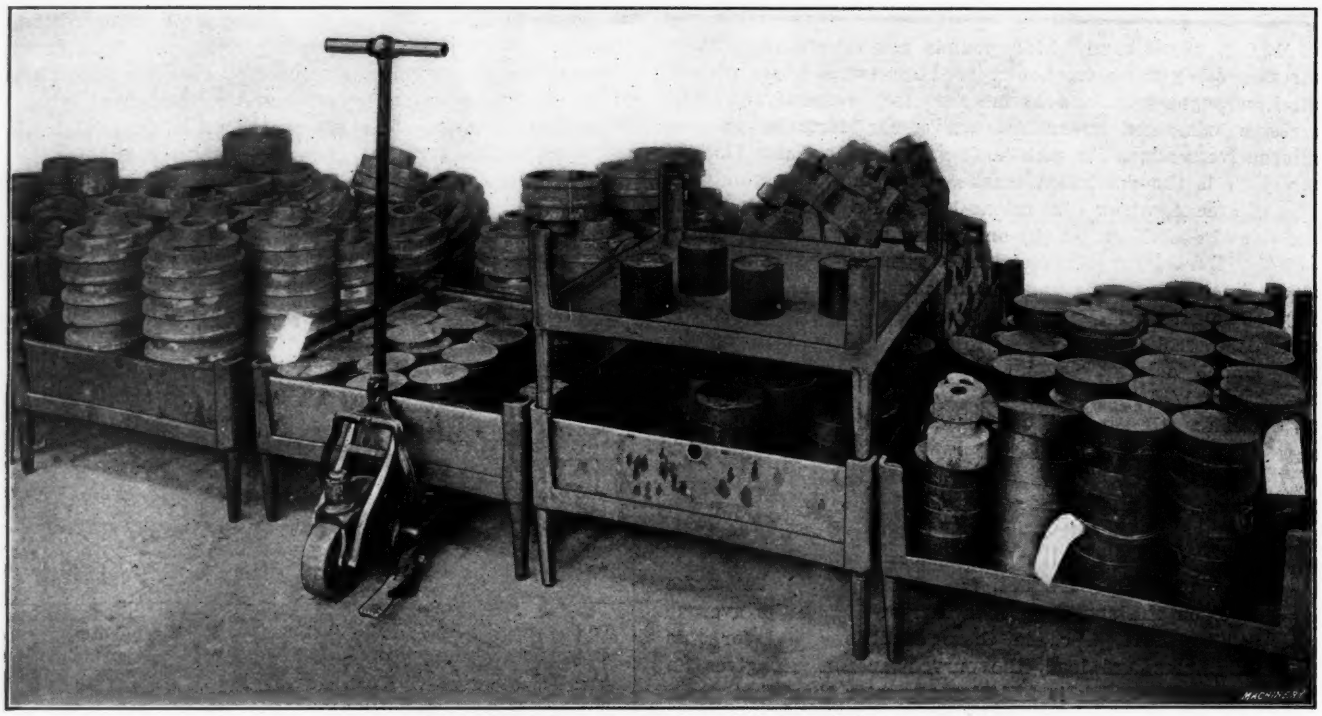
where y_2 is the distance from the center of gravity G of the section to the side c.

Example 3: Substituting in Formula (5) the quantities given in Example 1, and making $y_2 = d - y_1 = 4.12$, we have $S_c = 13{,}059$ pounds per square inch, which is less than 48 per cent of the maximum tensile stress in that section, as given by Formula (3). Both of these calculations show that the most economical form of section by the curved-bar theory is one of shallow depth d and of considerable internal width b. There are, however, practical objections to very wide hooks, in wearing qualities, facility in use, and especially when they are required for such bearings as the trunnions of a ladle, in which the bending moment and required diameter of the trunnion become larger, the greater the width of the hook. The theory should be of service, however, in checking up the stresses in existing hook sections and, when desired, in modifying those sections, in some degree, in the directions indicated above.

* * *

IMPROVED TYPE OF WORK-HOLDING BOX

The Jones & Lamson Machine Co., of Springfield, Vt., is using in the new factory an improved form of tote-box or work-stand for holding machine parts in process of manufacture. This form of container has several advantages over the ordinary work-holding box, principal among which is the fact that they may be stacked up one above the other and thus form practically a continuous stock rack. Also, the space beneath allows an elevating truck to be run under as shown in the photograph and the entire box or stack of boxes picked up easily and transported to any other part of the shop. If the work is small or of such a nature that it would easily tumble out at the sides, sheet iron strips are placed at each side, being held in position by lugs cast integral with the bottom of the box. Two of these lugs may be seen at the rear corners of the top box in the foreground. The stacking is made possible by providing the top corner posts with seats into which the legs of another box may be seated, thus holding the boxes securely in position. As the entire box is made of a single casting requiring no machining, the cost of making is low. C. L. L.



Work-holding Boxes in the Jones & Lamson Factory

* * *

There are 7500 manufacturers engaged in the wire and wire goods industries in Germany, employing about 125,000 operators. Of this number, 41,000 are engaged in the manufacture of nails, tacks and wire ropes, 7000 in the manufacture of pins and needles, 18,000 in the manufacture of wire goods, and 10,000 in land and submarine cables. The value of the goods produced is estimated at $119,000,000 a year, of which one-half is exported.

SCREW MACHINE TOOL EQUIPMENT AND ATTACHMENTS

SPECIAL TOOL EQUIPMENT AND MAGAZINE ATTACHMENTS USED ON THE CLEVELAND AUTOMATIC SCREW MACHINE

BY DOUGLAS T. HAMILTON*

THE variety of work adaptable to an automatic screw machine can often be greatly increased by the addition of simple attachments. In many cases, all the operations on a piece can be completed before it is removed from the machine, while without the attachments a second operation would be necessary. In other cases, automatic screw machine attachments can be used for handling second-operation work; they are also adapted to work on forgings and castings, performing such operations as drilling, tapping, counterboring, etc. Magazine attachments covering most of these points will be described in the following article.

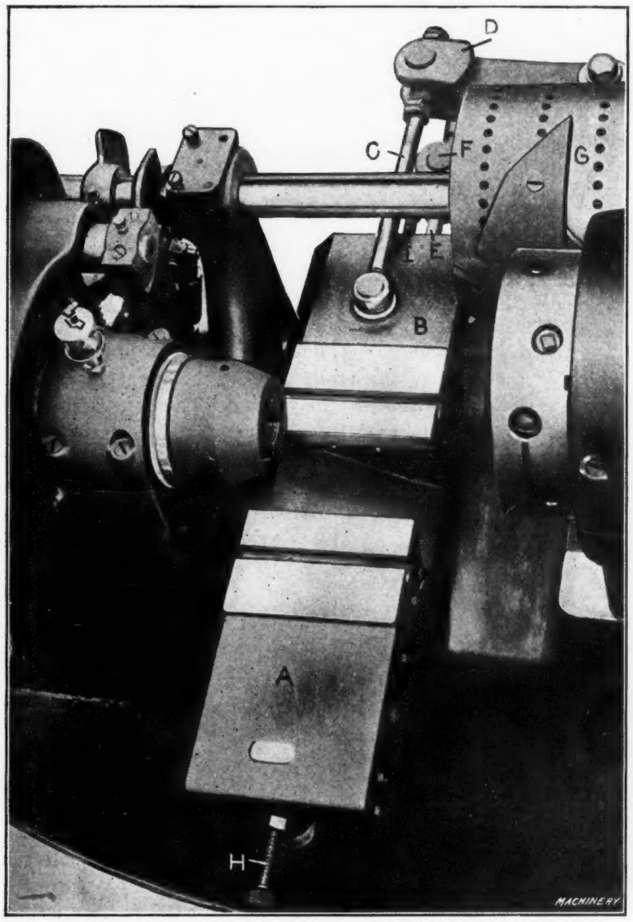


Fig. 1. Double Cross-slide for Independent Control of Cross-slide Tools

Double Cross-slides

For work on which both forming and cutting-off tools can be used to advantage at the same time, the double cross-slide arrangement shown in Fig. 1 is provided. In this case the front slide *A* and rear slide *B* are operated independently. Slide *B* is controlled by connecting-rod *C* and bellcrank lever *D*, whereas slide *A* is operated by connecting-rod *E* and bellcrank lever *F*. Connecting-rod *F* passes beneath both slides and is connected to the front slide *A* as illustrated. Both of these slides are operated by cams on the drum *G*. Positive stops *H* and *I* are provided to secure accuracy in forming, and these come in contact with a hardened plug in the base of the machine. The double cross-slides eliminate all lost time between the forming and cutting-off operations, as the cutting-off tool can be brought into position before the forming tool has finished cutting. Forming tools can be carried on both these slides when necessary, an independent cutting-off attachment, as described later, being used for cutting off the work.

Multiple Cutting-off Toolpost

The particular toolpost shown set up and in operation on the Cleveland automatic in Fig. 2 is arranged for carrying four cut-off blades *A*, which can be used for cutting off four pieces at once. Any reasonable number of tools may be applied in this manner, and the number of parts which may be cut off is limited by the depth of the hole which can be drilled or the length of the work that can be handled without springing away from the cutters. The holder *B* can be supplied with different widths of filling blocks which are placed between the blades and locate them at the proper distances for cutting off different thicknesses of work. The ejector bracket *C* is attached to the front of the bed below the cross-slide and carries an adjustable plunger *D* which strikes the stripper plate *E* and ejects the work from the blades when the cross-slide backs away. This ejector is operated by two springs *F* which bring the ejecting slides *G* back into the normal position when the cross-slide carries the cutting tools toward the work. This attachment effectively prevents the work from sticking between the cutting-off blades.

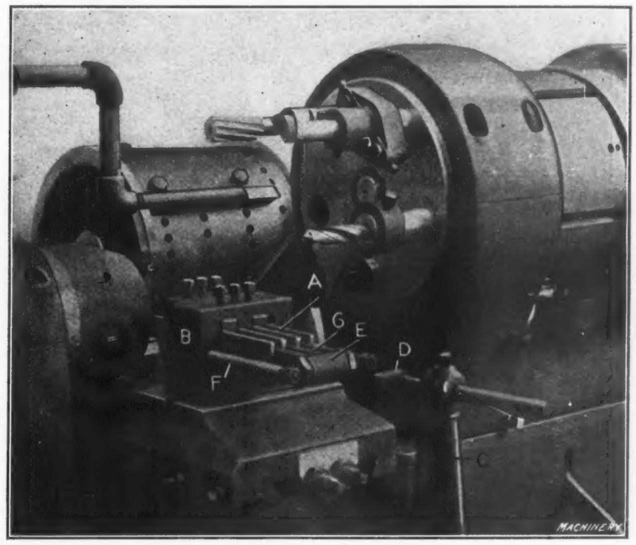


Fig. 2. Multiple Cut-off Toolpost

Independent Cutting-off Attachment

The attachment shown in Fig. 3 is used for cutting off the work when the tools on the rear and front of the cross-slide are used for forming operations. This attachment consists primarily of a swinging arm *A* mounted on a stud which is attached to the spindle head of the machine. The cutting-off blade is mounted in a holder *B*, at the forward end of the

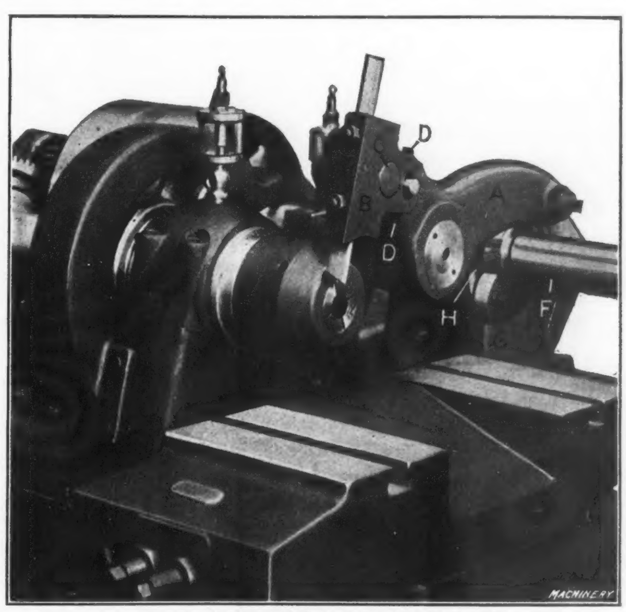


Fig. 3. Independent Cut-off Attachment

* Associate Editor of MACHINERY.

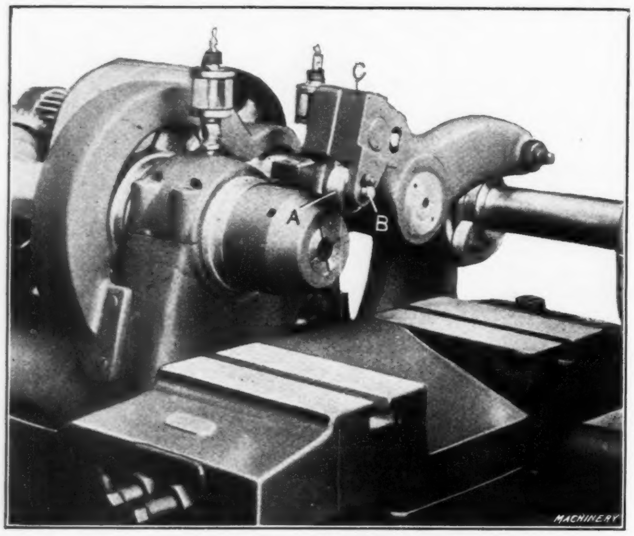


Fig. 4. Thread-rolling Attachment

swinging arm *A;* the holder *B* is fulcrumed on a bolt *C* which is provided with a locking nut on the opposite side for clamping the tool-holder in the desired position. The proper setting of the cutting-off blade is secured by means of the set-screws *D* which operate against a pin driven into the arm. To make this adjustment, it is necessary to release the nut on the clamping bolt *C*. This attachment is operated by the cam *G* held on the camshaft *F*, the cam being adjustably mounted on the disk *H* as illustrated. This cam contacts with a roll held in arm *A* and gives it the required movement at the desired time. The roll is carried on an eccentric stud, for fine adjustment of the cutting-off blade. The blade is clamped in the holder by two clamping bolts as illustrated.

Slotting and Slabbing Attachment

The attachment shown in position on the Cleveland automatic screw machine in Fig. 5 is used for slotting the heads of screws, slabbing operations and similar work. The operation is accomplished while the turret tool is working, so that there is no time lost by slotting. The operation on a screw is as follows: After the part has been finished, and is ready to be cut off, the turret advances carrying the screw slotting conveyor *A* which takes hold of the screw as it is severed from the bar. The stock is then fed forward and the turret tool commences on the next piece; at the same time the conveyor *A* carrying the screw that has just been cut off, brings the head into contact with the slotting saw *B*. By the time the turret tool has finished its cut, the saw has also completed its operation. The finished part is ejected from the conveyor by means of a pin *C*, upon the backward stroke of the turret. The slotting arm *D* carrying the saw *B* is a slight distance back from the face of the chuck hood so that it clears all the turret tools except when the conveyor *A*, carrying the screw, comes into line with it.

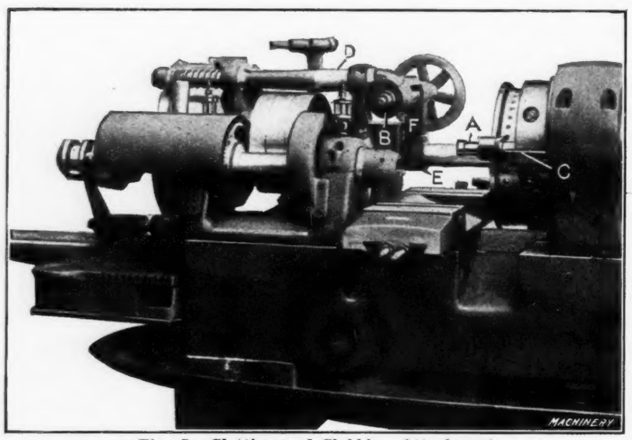


Fig. 5. Slotting and Slabbing Attachment

This attachment consists of the arm *D*, mounted in bearings secured to the spindle head. This arm carries the saw spindle which is driven by a belt from the countershaft. The drum which carries the chuck opening and closing cams carries, in addition, another cam which operates the slotting arm *D*. This cam moves the saw toward the turret when the conveyor *A*, held in the turret, advances with the part to be slotted. The bracket *E* is a good sliding fit on the rear shaft to permit of this movement. The entire slotting arms is returned to its original or neutral position by the coil spring shown, after the roll on arm *D* comes out of contact with the operating cam.

To fit up this attachment for slabbing operations, two slabbing cutters are mounted on the saw spindle in the same manner as the slotting saw *B*, and the same movement takes place as in slotting. It is also possible by means of a special slotting arm *D* to cut a groove or slot of any shape or depth lengthwise of a piece by raising the center of the saw spindle, so that the work will pass under the milling cutter or saw.

Thread-rolling Attachments

Fig. 4 shows the thread-rolling attachment. This is identical in construction with that shown in Fig. 3, except that the roll holder replaces the cut-off blade holder. As Fig. 4 shows, the thread roll *A* is held on a pin *B*, the latter being retained in position in the holder *C* by means of a collar-head screw. This thread-rolling attachment is used for producing a straight or taper thread behind a shoulder, and is particularly adapted for threading brass work. Thread rolling of steel has not been very satisfactory because of the difficulty experienced in securing a roll which will stand up to the work.

Die-closing Attachment

Self-opening dies equipped with chasers can be used with excellent results on the Cleveland automatic screw machine when an attachment for closing the die is provided. On the turret type or model A machine, an attachment of the kind illustrated in Fig. 6 is used. This consists of a bracket *A* which is fastened to the front side of the turret cap directly over the locking spline of the turret. The pin *D* in the die head comes in contact with swinging dog *C* and revolves the chaser cam ring a little beyond the locking position of the die head just as the turret has revolved to its locking position. This insures the positive locking of the die head when the turret advances; when the turret comes back into this position, the pin *D* strikes the edge of dog *C*, which swings back and allows the turret to turn to the next locking position.

Oil-feed Attachments for Turret Tools

The attachment shown in Fig. 7 is adapted to all turret model A machines, and also to the three-hole turret full automatic model C machine. It is used to supply oil to each of the turret tools. The valve mechanism which controls the flow of oil to the different turret tools permits the oil to flow

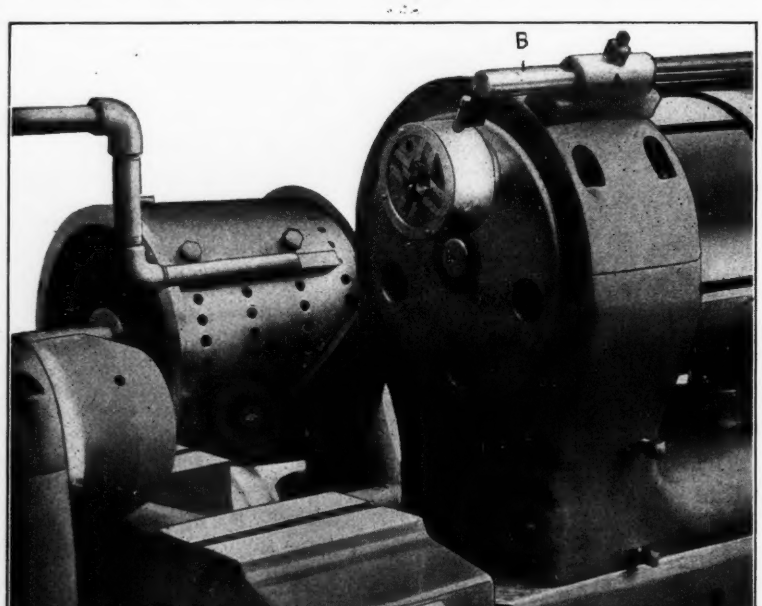


Fig. 6. Die-closing Attachment

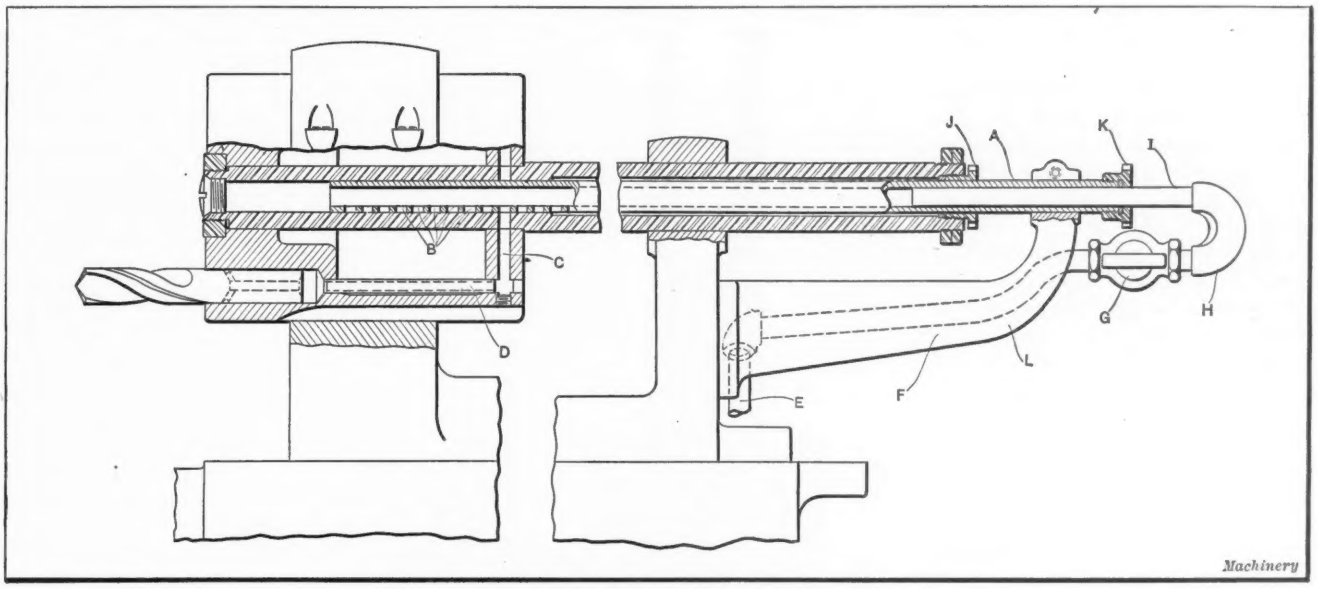


Fig. 7. Oil-feeding Attachment

only to the tool which is actually cutting and shuts it off from all the other turret holes. The starting and stopping of the flow is accomplished by the forward and backward motion of the turret shaft. The oil tube *A*, which extends inside the turret shaft, is the valve that controls the flow of oil. At the forward end of this main oil tube *A* will be seen a series of holes *B* which is a single row of holes at the lower part of the tube and extends for a length equal to the stroke of the turret. As the oil tube is held stationary in the bracket *F* at all times, the turret shaft, when moving forward or backward on the regular turret stroke, allows the hole *C* in the turret to pass over the series of holes in the tube, resulting in a flow of oil through these holes and the tube *D* to the turret hole and from there to the oil tubes in the tools.

The oil is received from the pump under pressure through the pipe *E* which is supported by the oil feed bracket *F*. The oil passes through the shut-off valve *G*, which is provided so that it can be shut off if not required or so that the amount can be regulated to suit the tools in the turret. From here, the oil passes through the return bend *H* into the short pipe *I*, and discharges into the main oil tube *A*. The stuffing-boxes *J* and *K* make oil-tight joints to prevent leakage. This system of oiling from the turret is much more efficient than from pipes located above the tools, because it serves to force the oil directly to the point of the tool where the actual cutting is being done and washes the chips out. Drilling speeds considerably in excess of those recommended when ordinary oiling facilities are supplied can therefore be used when an oil feed attachment of this type is applied to the turret tools.

Fig. 8. Rotary Tilting Magazine Attachment in Position to have Work removed by the Conveyor held in the Turret

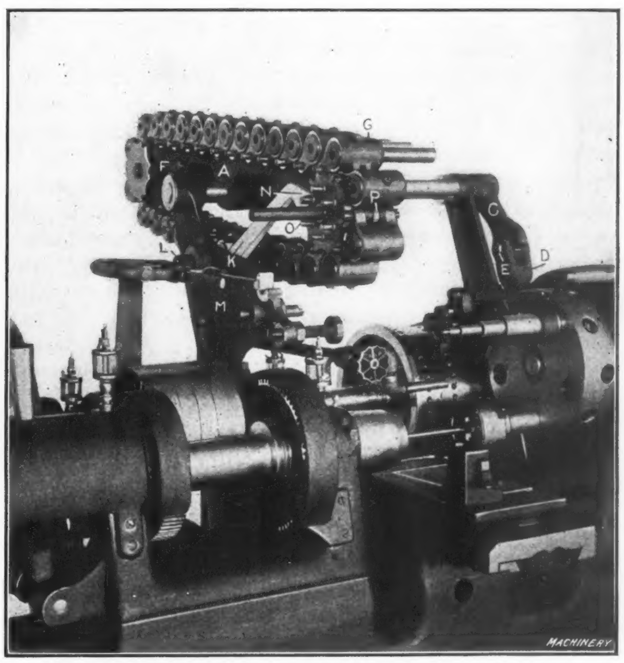


Fig. 9. Rotary Tilting Magazine Attachment tilted up to clear the Turret Tools

Vertical Magazine Attachment for Studs and Similar Work

Fig. 10 shows a magazine attachment which is adapted to the models A and B Cleveland automatics. It is used principally for feeding studs or similar work to the chuck for second-operation work. The sides of the magazine can be adjusted for different lengths and diameters of work by means of the adjustable strips *A* and the removable bushing *B*. The pieces feed down to the bushing *B* by gravity and are pushed into the rear end of the spindle by a rod *C* which is operated by cams on drum *D*. The entire magazine attachment may be removed by taking out the screws *F*, when the feed yoke *E* is swung into working position and the machine is then ready for bar work. The attachment illustrated is exceptionally easy to operate and is efficient for handling studs which must be threaded after cutting off, or work that requires threading on both ends, counterboring, tapping, etc.

Rotary Tilting Magazine

Two views of a rotary tilting magazine attachment are shown in Figs. 8 and 9. Referring to Fig. 8, the frame *A* is mounted on the shaft *B*, which has a long spline milled on the upper side, allowing the frame, which is fitted with a

square key, to slide in any position to suit the work to be machined. Lever *C*, Fig. 9, is made fast to shaft *B* and is slotted on its lower end to engage a roller in lever *D*. This roller is mounted on an eccentric bolt *E* which allows adjustment for wear by swinging the magazine up and down. Lever *D* is pivoted on a stud in its center and carries a roll at its lower end, which engages a disk cam on the main cam-shaft of the machine. With the rotation of the cam-shaft, the disk cam brings the magazine down as shown in Fig. 8. The frame *A*, Fig. 9, has an adjustable bearing at each end; the bearing *F* at the upper end can be moved to tighten or loosen the link-belt *G*; the bearing at the lower end can be moved forward or backward to maintain the alignment of the hole in the links with the turret hole when the magazine is in the position shown in Fig. 8.

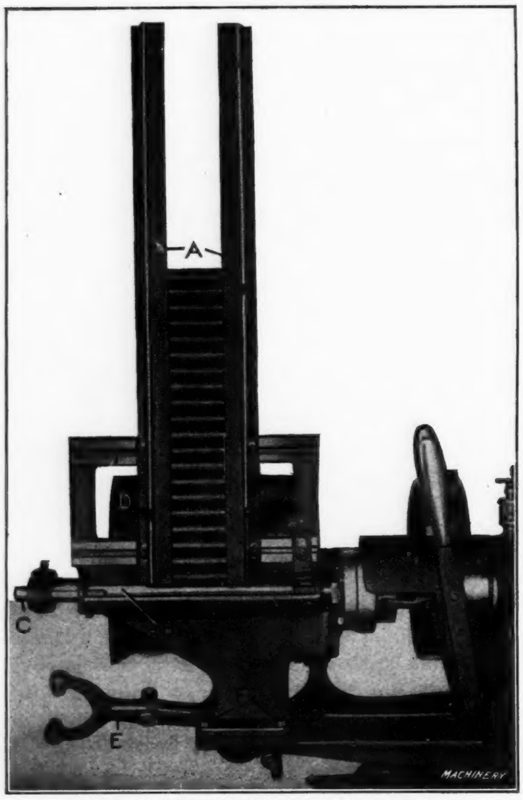


Fig. 10. Vertical Magazine Attachment

The sprocket wheels upon which the link-belt *G* is mounted are rotated upon the downward motion of the magazine, as it comes into the working position. This is accomplished through the medium of the pawl *K* which swings on a stud *L* in arm *M*, and engages pins *N* in the lower sprocket wheel. When the magazine swings up, this pawl *K* drops onto the pin *O*. The links *G* are fitted with rollers *P* which allow the chain to pass freely over the top of frame *A*. Each link *G* is provided with a bushing especially shaped to suit the work to be machined, and can be adapted to any irregular shape that can be gripped in the chuck. Fig. 8 illustrates the magazine in its working position with the conveyor advancing to remove the work. The magazine is brought into this position as soon as the turret is indexed and swings up into the position shown in Fig. 9, as soon as the turret starts to index to its next position.

* * *

FORMULAS FOR CHORDAL THICKNESS AND CORRECTED PITCH DEPTH

BY JAMES T. BROCKWAY*

When special accuracy is desired in the cutting of bevel gears so as to obtain a theoretically correct thickness of the tooth, as in automobile practice, etc., designers find it necessary to compute the "corrected pitch depth" (or the distance $d + x$, Fig. 1) and the chordal thickness of the teeth at the pitch line. First it is necessary to determine the angle *b*, Fig. 1, subtended by lines from the apex o_1 of the back cone (see also Fig. 2), which intersect one side and the center of the tooth, respectively, at the pitch line. The conventional formula for determining this angle is as follows:

$$\text{Angle } b = \frac{1}{2}\left(\frac{360°}{\dfrac{\text{Circumference of back cone distance circle}}{\text{Circular thickness}}}\right) \qquad (1)$$

The "back cone distance circle" referred to in the formula is a circle having a radius o_1y (Fig. 2); the term "circular thickness" relates to the thickness of the teeth along the arc yy_1, Fig. 1.

This formula has proved both long and cumbersome and the writer has devised an improved formula which shortens the calculations considerably. The derivation of this formula is as follows: In Figs. 1 and 2, *o* is the center of the gear; *oy* and oy_1 are pitch radii; o_1 is the apex of the back cone, and o_1y and o_1y_1 are back cone radii, or, expressed in another way, o_1y is the back cone distance, and *wy* is the pitch cone distance. In Fig. 1, where, for the sake of clearness, only one tooth of the gear is represented and that enlarged, it is evident that

$$\text{Angle } c = \frac{360°}{\text{No. teeth} \times 4} = \frac{90°}{\text{No. teeth}}. \qquad (2)$$

From Fig. 2:

$$yo_1 = \frac{yo}{\text{cos pitch angle}}.$$

$$\sin b = \frac{\frac{1}{2}t}{yo_1} = \frac{\frac{1}{2}t \text{ cos pitch angle}}{yo}. \qquad (3)$$

$$\text{Sin } c = \frac{\frac{1}{2}t}{yo}. \qquad (4)$$

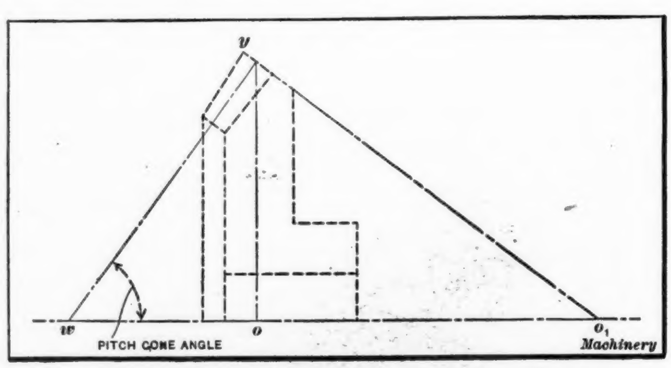


Fig. 2. Diagram showing Relation of Points o and o_1 Fig. 1, to Bevel Gear

Therefore combining Equations (2), (3) and (4),

$$\text{Sin } b = \text{Sin}\left(\frac{90°}{\text{No. teeth}}\right) \text{cos pitch angle.} \qquad (5)$$

When the thickness of the tooth is not half the circular pitch, then Formula (5) becomes

$$\text{Sin } b = \text{Sin}\left(\frac{90°}{\text{No. teeth}} \times \frac{\text{circular thickness}}{\frac{1}{2} \text{ circular pitch}}\right) \text{cos pitch angle.} \qquad (6)$$

The "corrected pitch depth" $(d + x)$ and "chordal thickness" (*t*) Fig. 1, are then found by the usual method, *i. e.*,

$$d + x = d + [o_1y\,(1 - \cos b)]$$

$$t = 2 \times o_1y \sin b$$

* * *

A patent on marking negatives for identification at the time of exposure was sold for \$300,000.

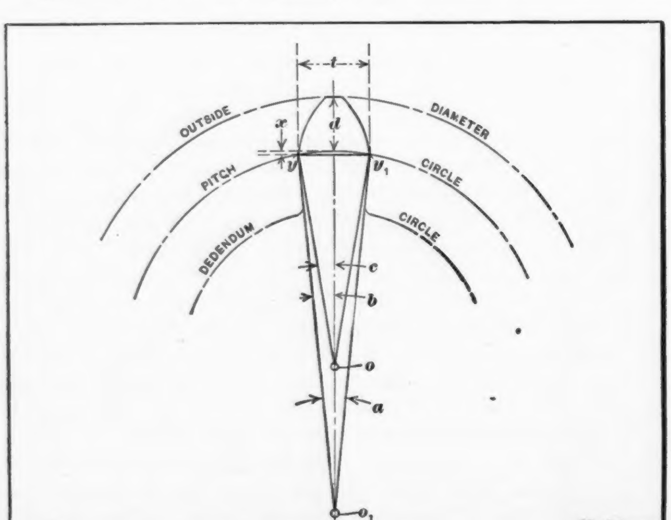


Fig. 1. Diagram of Bevel Gear Tooth, with Notation used in Formulas

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DISK-AND-BUTTON METHOD OF LOCATING HOLES

PRACTICAL TOOLMAKING METHODS OF IMPORTANCE IN ACCURATE WORK

BY GUY H. GARDNER*

EVERYONE who has had experience with the button and micrometer method described by D. Dalton in the June number of MACHINERY—and I suppose all of us who are engaged in toolmaking employ it almost daily—must recognize its excellence and also its one fault.

The accuracy of work done by this method is limited only by the skill and painstaking care of the workman, but it consumes a great deal of time.

By a little modification, using what is sometimes called the "disk-and-button method," a large part of this time can be saved without any sacrifice of accuracy. While the disk-and-button method is extensively used in many shops, it is a curious fact that many highly skilled toolmakers have never even heard of it. Buttons are used, but they are located in the center of disks of appropriate diameters. As three disks are used in each step of the process, it is sometimes called the "three-disk method."

Mr. Dalton's first example of work presents an ideal opportunity to demonstrate the superior celerity of this way of working. It calls for the location of six holes, equally spaced, in the circumference of a circle six inches in diameter. To locate these one needs, besides the buttons, three disks three inches in diameter, each having a central hole exactly fitting the buttons. It is best to have, also, a bushing of the same diameter as the buttons, which has a center punch fitted to slide in it.

First the center button is screwed to the templet, and one of the disks *A*, Fig. 1, is slipped over it; then a second disk *B* carrying a bushing and center punch is placed in contact with disk *A* and a blow on the punch marks the place to drill and tap for No. 2 button, which is kept in its proper place while tightening the screw by holding the two disks *A* and *B* in contact. Next the third disk *C* is placed in contact with disks *A* and *B* and locates No. 3 button, and so on until the seven buttons are secured in position. The templet is then ready to be strapped to the lathe faceplate for boring. A man who recently tried this method on a templet identical with the one referred to (except for dimensions) informs me that the time, aside from drilling and tapping the holes, was less than forty-five minutes, and he is confident that he can reduce this materially on the next job. This templet was examined by a very critical and "fussy" inspector who reported, "No measurable inaccuracy."

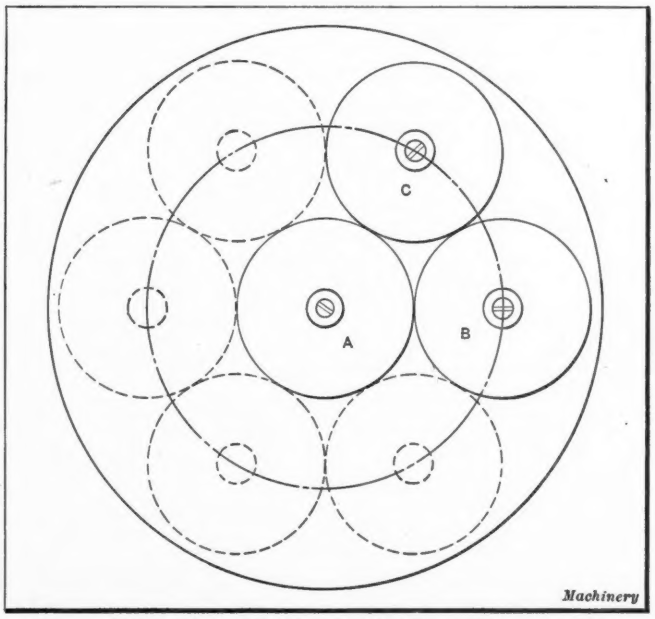

Fig. 1. Disk-and-button Method of locating Six equally spaced Holes

All cases, however, cannot be handled with disks of "standard" sizes, but making a special disk is easy, and its cost is insignificant as compared with the time saved by its use. One who employs this method, especially if he also uses disks to lay out angles, soon accumulates a stock of various sizes. While it is desirable to have disks of tool steel, hardened and ground, or, in the larger sizes, of machine steel, casehardened and ground, a disk for occasional use will be entirely satisfactory if left soft.

The hinge jig templet shown in the article previously referred to can also be handled advantageously by this method. Sketch *A*, Fig. 2, gives its dimensions and sketch *B* shows the disk-and-button way of locating the holes. A steel square is clamped with its stock against the right-hand edge of the templet and its blade extending across the top. The lower edge of the blade should be located 0.250 inch from the upper edge of the templet by the use of size blocks. A 2½-inch disk, touching both blade and stock, locates hole *C*. Another 2½-inch disk, touching the first disk and the square blade, locates hole *B*.

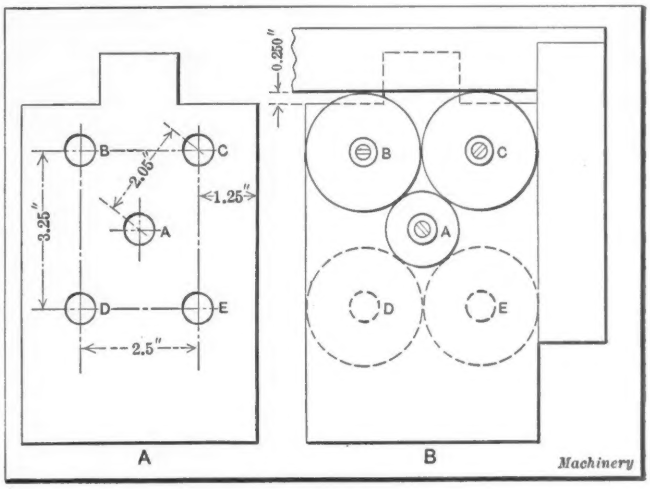

Fig. 2. Locating Five Holes in Jig Templet by the Disk-and-button Method

Next a disk 1.600 inch diameter is placed in contact with the two upper disks and locates the center hole *A*; and, finally, the disks for holes *B* and *C* are used to locate holes *D* and *E*.

Two other jobs that illustrate this method may be of interest. The first one, shown in Fig. 3, required the locating of nine equally spaced holes on a circumference of 7⅜ inches diameter. In any such case, the size of the smaller disks is found by multiplying the diameter of the circle by the sine of half the angle between two adjacent disks. In this case $7\frac{3}{8}$ inches $\times$ sin $20° = 2.5224$ inches; $7\frac{3}{8} - 2.5224 = 4.8526$ inches, which is the diameter of the central disk.

The templet shown in Fig. 4 required two holes on a circumference 6½ inches diameter, with their centers 37 degrees 20 minutes apart. $6\frac{1}{2}$ inches $\times$ sin $18° 40' = 2.0804$ inches, which is the diameter of the two smaller disks. The diameter of the larger disk $= 6\frac{1}{2} - 2.0804 = 4.4196$ inches.

This method has one unavoidable defect which, however, is seldom noticeable in the ordinary run of shop work. It is impossible to calculate certain dimensions with absolute accuracy, nor could we work to them if they were known. For instance, in the class of work of which Fig. 3 is an example, if the diameter of the small disks is determined to, say, the sixth decimal place, it will be followed by a + sign, and we know that there would still be the + sign if we carried the calculation to sixty or even to six hundred places of decimals; hence when figuring to six places and working to the nearest 0.001 inch, we may find either that the outer disks seem too large and will not assemble properly or that they appear small, leaving a slight shake between them.

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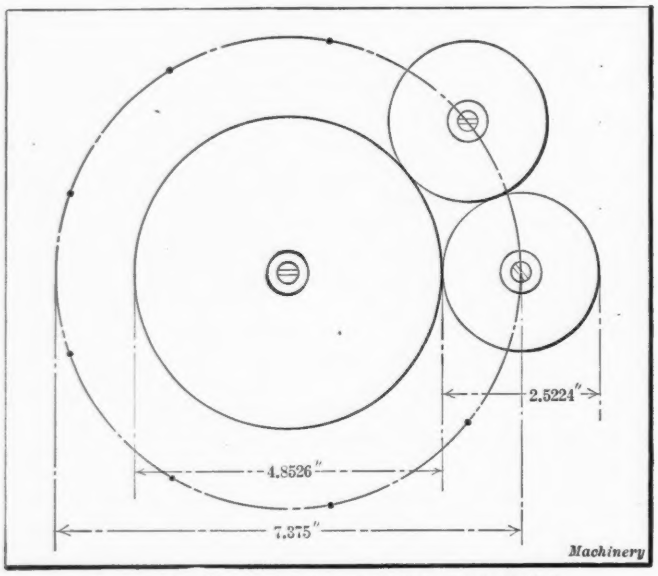

Fig. 3. Another Application of the Three-disk Method

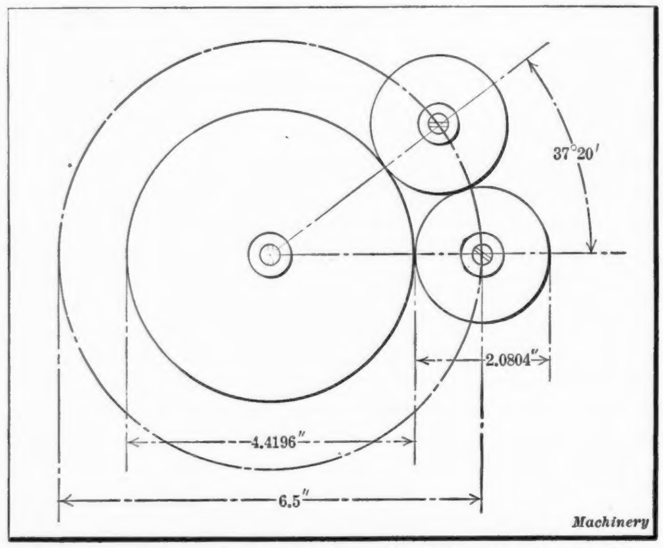

Fig. 4. Illustrating Use of Disks for locating Holes at a Given Angle

This error, however, is too small to be measured and is of no importance except in work requiring very unusual accuracy, and even then can be avoided by leaving the central disk a little full, and, if trial shows it to be necessary, returning the central disk to the lathe and giving it a very light touch with a lap.

Of course, absolute exactness is equally unattainable with buttons and micrometer or any other method, but the micrometer does not show the slight inaccuracy in any one chordal measurement, while in using the disks the error is cumulative and the insertion of the last disk in the series shows the sum of the errors in all the disks. It is only in cases like Fig. 3 that we note this, and there, though in correcting the error we may change the diameter of the circle by a small fraction of a ten-thousandth, a more accurate division of the circumference is secured than is attainable by any other method.

A piece of work requiring a high degree of accuracy was successfully handled by an extension of the three-disk method, after an excellent workman had attempted to do the work on the shop's best milling machine. The accuracy obtained with the milling machine was everywhere well within a 0.0005 inch limit, but the work was rejected because it was not close enough to the required dimensions.

The drawing called for fourteen holes in a space hardly larger than a silver half-dollar, and, though it gave dimensions from the center of this circle, the actual center could not be used in doing the work, as there was to be no hole there; moreover, a boss slightly off center prevented the use of a central disk, unless the bottom of the disk were bored out to receive this boss, which was not thought expedient. Hence, the method adopted was to make the plate thicker than the drawing prescribed, and then bore it out to leave a rim of definite diameter, this rim to be removed after it had served its purpose as a locating limit for the disks.

As the holes *A* and *B* (see enlarged view, Fig. 5), which were finished first, were 0.600 inch apart and 0.625 inch from the center, the rim was bored to 1.850 inch, and two 0.600-inch disks, in contact with the rim and with each other, located these holes. As hole *C* was to be equi-distant from holes *A* and *B*, and its distance from the center was given, the size of the disk for this hole was readily determined. The disks for holes *A*, *B* and *C* have two diameters. The upper diameters are made to whatever size is required for locating the disks of adjacent holes, and they also form a hub which can be used when setting the disks with an indicator. Hole *D* was 0.4219 inch from *B*, and calculations based on this dimension and its distance from the center showed that it was 0.4375 inch from hole *C*.

A "three-story" disk or button was made for hole *D*. The diameter of the large part was 0.46875 inch and it overlapped disks *C* and *B* (the upper sections of which were made 0.375 inch and 0.40625 inch, respectively), thus locating *D*. Then hole *F* and all the remaining holes were located in a similar manner. The upper diameters of disks *E* and *D* were used in locating disks for other adjacent holes, as well as a hub for the indicator; for instance, to locate a hole with reference to holes *C* and *D*, the diameter of the new disk and the diameter of the upper part of disk *D* were varied to give the required location.

It had been decided that no screws should be used in attaching the buttons or disks to the work, as it was feared that the tapped holes would introduce inaccuracy by deflecting the boring tools; therefore, a method was employed which was new to all who saw it, though I am told that it is frequently used in certain branches of the trade. After all the disks were fastened in place by clamps, a soft solder of low melting point was flowed about them, filling the work to the top of the rim. When the solder had cooled, the clamps were removed, the job transferred to the lathe faceplate, indicated in the usual way, and the holes bored by a "D" or "hog-nose" drill, guided by an axial hole in each disk, which had been provided for that purpose when the disks were made.

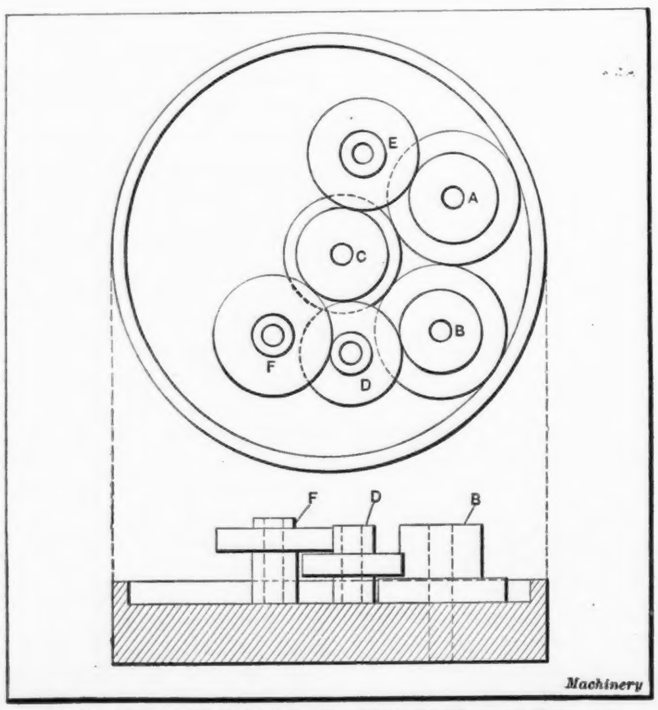

Fig. 5. Accurate Method of locating Holes by Means of Temporary Annular Rim on Work and "Two- and Three-story" Buttons or Disks

It had been freely prophesied that the unequal contraction of the solder and the plate in cooling would throw the holes "out of square," and I am by no means sure that it did not. However, careful measurements by several men failed to show any error.

PATENTS FROM A PATENT ATTORNEY'S VIEWPOINT

BY FORD W. HARRIS*

I have been reading Bell Crank's article on "Filing your Own Patent" in the July number of MACHINERY, and like most of the material in MACHINERY it contains a great deal of good common sense. It is, however, always well to get the other fellow's viewpoint, and it might be well to consider the patent attorney's way of looking at the matter.

In the first place as to searches: the average shyster patent lawyer will give you to think that the government is in some way involved in making searches. This is not correct. The only way that you can get the patent office to make a search is to present to them a formal application for a patent. The so-called search or preliminary examination that the average inventor buys is made by a Washington lawyer. This lawyer may be on sufficiently good terms with some of the examiners so that he can get a tip from them as to the classes or sub-classes in which interfering patents may be found, but in general he makes the search entirely on his own resources. The value of the search is a direct function of the personality of the searcher. If he is a conscientious man, he will make a pretty good search and the result may be depended on within certain limits. These limits are due to causes quite beyond the control of the searcher. In the first place, it must be understood that there are no adequate facilities for searching foreign patents, and a foreign patent is quite as valid a reference against an application as a domestic patent; in addition, no search will tell you just what there is pending in the office. A search is merely an indication of what may be expected. If the searcher finds patents that disclose the invention, it is conclusive; if he does not, there is no guarantee that those patents do not exist. The usual charge for such a search is five dollars, and it is evident that no competent man can put in much time at that figure. Personally, I believe it generally pays to have a search made by a good attorney.

As to attorneys, I do not believe in doing business with any attorney who advertises in any other way than by a business card. If he uses catch phrases such as "no patent, no pay," "meretorious inventions financed," etc., or if he advertises lists of inventions wanted or the like, I figure that he is a good man to leave alone. Personally, I believe in local attorneys, and I want to know that my attorney has been in business for some time, and I also want to know one or two satisfied clients of his before I do business with him. In addition, I want to see a few of the patents that he has obtained. I figure that if he gets broad claims for one man, he can get them for another.

There is no doubt that any inventor will make money by prosecuting a few patents for himself. He will get a lot of hard knocks and may get a very poor patent, but it is well worth trying. I would not trust any of my masterpieces to a green prosecutor, but there is no reason why an inventor cannot try out his hand on some simple case first and see how he gets along. He cannot hash it up much worse than a poor attorney, and he certainly will get a line on what such prosecution means.

As to the thoroughness of patent office searches I must differ a little with Bell Crank. The average office search is not thorough and that is one of the chief reasons for the present distrust of patents. If the patent office had the men and facilities to make good searches there would be very few invalid patents. A patent is usually invalid because some infringer can produce proof that the invention was not original with the patentee. The need for better examinations is the one big need in the patent office today. No man who has handled a large number of cases before the office will deny this. It is shown in two ways. The first is in the large number of patents that are declared invalid by the courts, and the second, in the fact that it is often possible to get claims that the inventor himself knows are clearly anticipated by the prior art. This is, however, a relative matter. As compared to the usual preliminary examination made by a patent lawyer the office search is perfect. As compared with what it should be it is not so good. I think we should pay higher filing fees and allow the patent office to spend the money in salaries and facilities for better examinations. Our patent system is the pivot around which many industries revolve and we ought all of us to pull for higher efficiency in the office.

As to the requirements for admission to practice before the patent office, Bell Crank is absolutely correct. The requirements are not hard, not one-tenth as hard as they should be. I understand that they are a little more strict than they used to be, but they ought to be tightened up a great deal more. It is no secret that there are many men who are absolutely incompetent who are registered attorneys. I do not think, however, that legal training has much bearing on the matter. The prosecution of cases before the office involves many questions of fact and a very few of law. The legal questions are not very knotty, and a few months study of elementary law, to get the proper attitude of mind, and a diligent study of one or two law books on patents will give a man all the equipment he needs to be a successful practitioner. On the other hand, the average lawyer who is thoroughly educated in general law will be about the worst man to whom to take a case that could be found. A patent lawyer should be about eight-tenths engineer or inventor and two-tenths lawyer. If he has the mechanical gifts he can pick up the law, but unless he has a constructive imagination and the mechanical sense he will never get it by studying law books.

I have been particularly interested in reading the closing paragraph of Bell Crank's letter. Here again he is right, but there is a great deal to be said on the other side. It is correct that no patent lawyer makes a practice of taking cases and taking an interest in the patent as payment. This is undoubtedly correctly attributed to the fact that the lawyer knows that the majority—the big majority—of patents will never pay the cost of prosecuting. This is not all the story, however. The lawyer knows that most patents are of no value, but he does not know which ones are of value. In other words, he cannot tell before he prosecutes a case whether he is going to get a good patent on it or a poor one. Allowing that nine patents out of ten are of no value, the tenth one may bring in ten times the cost of all the others. The bad patents are the quartz in which the values are imbedded and they must go to the mill before the good patent can come into its own. This matter of looking at a set of drawings and telling an inventor whether he can make money out of his invention is about like predicting the weather a year ahead. Years ago I thought I could do it, but as I get more experience I become more and more careful about expressing an opinion. Moreover, it is sometimes possible to make money on a poor patent and on a poor invention by going after the business end of it vigorously. I remember very well an old gentleman who came to me once to get my opinion on an invention that he was thinking of purchasing. The patent had not been allowed and the invention itself was a little indefinite as to its novelty. After an examination of the device itself it seemed pretty evident to me from my knowledge of the art that the inventor was not going to get much of a patent. I had had a similar case in which I had had several references that completely anticipated the alleged invention in this case. I told the intending purchaser this, and, moreover, I told him that I believed that a certain pipe that figured actively in the operation of the invention had really no useful function at all; that is, I believed that it would work just as well if this pipe were left off. The old man looked at me.

"Mr. Harris." he said, "there are just two people in the world that know that; you are one and I am the other. I got suspicious of that pipe about a month ago and slipped in here and plugged it with a cork stopper, and I find it works even better plugged than it did open."

I then asked him what he was going to do about purchasing in view of the fact that it was very unlikely that he could get a patent and in view of the fact that this apparently essential pipe which formed so large a part of the supposed invention was nothing more than a fake. He then explained

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that he already owned the manufacturing rights under a royalty and that the inventor proposed to sell his royalty rights for a certain sum—two thousand dollars to be exact. He had consulted me merely to get a confirmation of his own opinion that the invention considered as an invention was of very little value. He then asked me to have the necessary papers drawn up to cover the transfer of this royalty to him, and said that he would give me a check payable to the inventor which I could hand to him when he signed the assignment. I was naturally a little surprised and showed it, and he went on to say that he had already sold fifteen thousand dollars worth of the devices, that he expected to sell as many more, and that he was only giving the inventor a small slice of the money he had made.

This case has always seemed to me to show the absolute impossibility of judging in advance of the money making possibilities of any invention. If the inventor had come to me to handle this particular case I would have refused to have anything to do with it. It was a meretorious device, but with the pipe left off it was not patentable. The pipe looked plausible and helped to sell it and the natural merit of the remaining parts sold others. I cannot see that anyone was really essentially cheated, as it did the work for which it was sold better than any device then on the market, and the public was well pleased with it. The inventor got two thousand dollars plus considerable royalty on the early sales, and my client got the profit on a great many that he sold. Judged by any practical standard it was a good invention. Judged by its merit in a patentable sense it was a joke.

Then again I have seen some of the cleverest things that apparently were destined to make a great deal of money turn out to be rank failures; so I do not blame a patent lawyer for taking the business as it comes and getting the best patents that he can. I do blame him if he misleads the inventor as to his chances of getting a good patent, or as to the nature of the patent that is finally allowed. Once upon a time during a stringency in my personal finances I tried the job of making patent office drawings for a local attorney. There was an old draftsman and myself in the office in addition to the usual clerical force. One day the junior partner brought in a client—a young mechanical draftsman—who had invented a new style drawing instrument, or rather had made a simple change in one of the common tools we all of us use. The junior partner showed it to me and asked me what I thought of it. I did not think it was new, but I hesitated to tell the inventor so, and while I was debating just what to say, the junior partner saw that I was not going to become enthusiastic and he switched to the old man asking him if he had ever seen anything like it. The old man said that he had not.

"Well," said the junior partner, "I have been in this business for fifteen years and Mr. Jones here has been in it for forty-five, and we have neither of us seen anything like it, so I guess it is all right," and he took the young man out to enter the case. After they had gone out the old man came over and showed me practically the same thing on one of his tools. I asked him why he had not told the junior partner about it and he grinned.

"This used to be his," he said, "he gave it to me when he got promoted from the drawing-board."

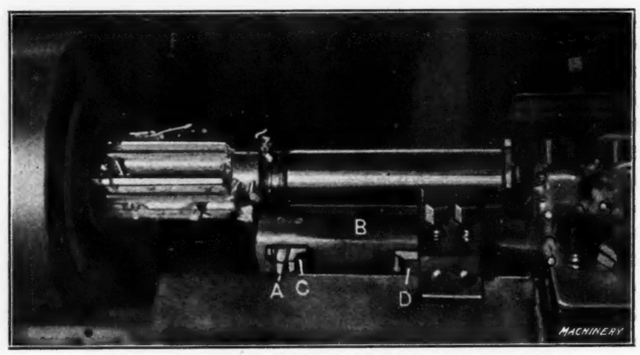
I did not stay long enough to find out whether the inventor got a patent or not, but I did stay long enough to find out that one way to be a "successful" patent lawyer was to say that every invention was fine, and to tell every inventor that he was a genius.. This particular attorney has allowed one of the finest patent practices in this part of the country to go to seed and it is only a question of time when he will have little or no practice left. It is his kind that have made the name patent attorney a joke to those who are at all well posted, and who have put into the office thousands of worthless applications and caused the inventors of the country the loss of hundreds of thousands of dollars.

I believe in patents—good patents. They offer about the only legitimate road to fortune for the working man who does not have exceptional qualities and superhuman luck. All this talk about inventions being "no good" is to my mind foolishness. Edison is occasionally quoted as saying something of the kind. I notice that he is a busy little bee putting in applications, however. A good patent is a very valuable piece of property and there are more of them than one thinks. There is a great deal of foolishness in patent practice that must be eliminated. We need a better patent office and better attorneys, and we can get along very nicely with about one-third of the patents that are now issued. I think that we are going to have some legislation some day that will materially clear up the present situation, and any changes must favor the inventor. If you have an idea that you think is of value, spend a few evenings studying the subject and take a try at prosecuting an application yourself. If it comes along all right, it may pay you to get a good lawyer. If you can get a first-class patent on a good invention there is money in it, but remember that push and grit are as necessary to an inventor as to any other man, and that money will not drop in your lap just because you have turned up a bright idea.

* * *

RAPID BORING AND REAMING OF BABBITT-LINED BUSHINGS

In finishing the babbitt-lined bushings for use in the Pierce-Arrow engine, the Pierce-Arrow Motor Car Co. of Buffalo, N. Y., uses a very effective type of tooling on a Gisholt lathe.



Boring and Reaming Tools for Babbitt-lined Bushings

The bushings are of the split type and the two halves are held in a collet and bored with tool *A* held in a fixed position on the bar *B*, which in turn is attached to the cross-slide of the lathe. After boring, bar *B* is run through the bushing so as to bring tools *C* and *D* at the exact edges of the hole. These being in fixed positions are fed toward the operator, thereby cleaning off the ends of the bushings and chamfering the corners. This being done, the hole in the bushing is rough-reamed and finally, as shown in the photograph, is finish-reamed, using McCrosky adjustable reamers. The result is a mirror-finish hole, and moreover the work is produced at the rapid rate of from thirty to forty pieces an hour. C. L. L.

* * *

A riveted sheet steel siphon ten feet in diameter carries water to Los Angeles across the Antelope Valley. Recently a great storm visited the valley and the resulting flood undermined the supports of the aqueduct, causing it to break in two. The shell being unsupported by internal pressure and being subjected to external pressure due to the flood, collapsed for a distance of nearly two miles. Apparently the pipe would have to be reconstructed at great expense, but the engineer in charge decided that it could be restored to shape by simply stopping the broken ends of the pipe and turning the water pressure into it. This was done, the result being that the pipe assumed its normal shape and very few leaks developed.

* * *

The summit of the Vigiljoch mountain in Switzerland, 3780 feet high, has been made accessible by means of a wire rope railway in two sections, worked electrically. The length of the slope is 7216 feet, the longest span being 656 feet horizontally. There are two cars for each section, with a capacity for carrying fourteen passengers, one car traveling up when the other is coming down.

METHODS OF HANDLING ECCENTRIC WORK

CONSTRUCTION AND OPERATION OF SPECIAL DEVICES FOR ECCENTRIC TURNING AND BORING

BY ALBERT A. DOWD*

CASTINGS or forgings having two or more cylindrical surfaces eccentric to each other may be machined by a variety of methods, that most suitable for any particular case being dependent upon a number of variable factors. In order to handle the work to the best advantage, these factors must be carefully considered. In the first place the machine most suited to the work must be selected, and this point is partially dependent on the size and shape of the work itself. The number of pieces to be machined is an important factor, in that it has an influence on the permissible tool outlay, for it is apparent that a high tool cost would not be expedient in the case of a lot of 200 pieces; whereas, if 5000 pieces were to be machined the cost of tooling and fixtures could almost be neglected provided substantial gains in production were to be made by some improved method of handling. There are cases when the work can more profitably be handled in two settings by means of a fixture, while in other instances the

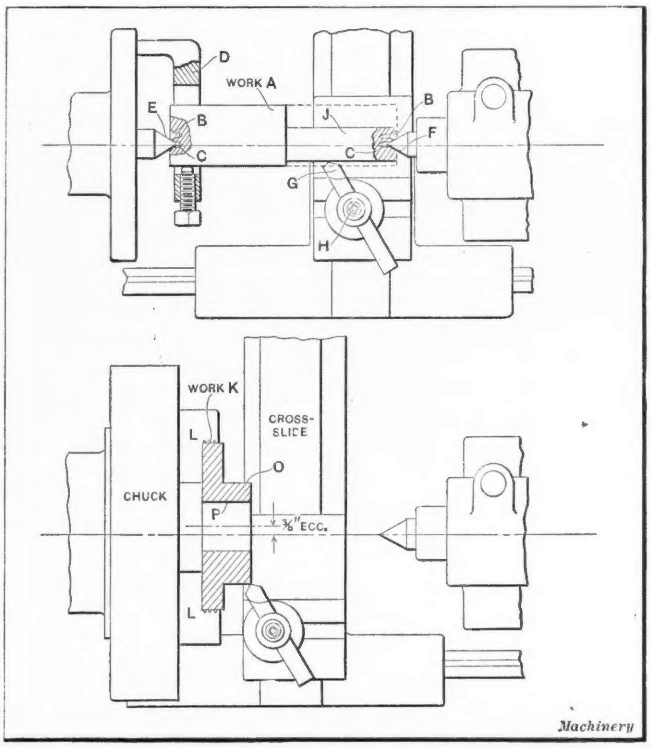


Fig. 1. Eccentric Turning in the Lathe

use of an eccentric turning device seems to offer the best solution of the problem. In the first case, a fixture of some sort is required and this usually presents no serious difficulties to the designer unless the work is very complicated. However, if an eccentric turning device seems warranted (as might be considered advisable if a great number of pieces were to be machined), it would then be necessary to design something on this order which would produce the work in the shortest possible time.

In the design of fixtures and devices for eccentric work there are a few points which require most careful consideration. Let us first give our attention to those which relate to special fixtures, for these points may be quickly summarized: If the work is to be finished in one setting, then some form of indexing fixture must be designed which will give the correct amount of "throw" when it is set over, and a great deal of care is required so that no change in the clamping of the work will be necessary between the first and second settings of the fixture. Indexing points, bushings and pins should be protected from dirt and chips so that inaccuracies will not occur due to imperfect contact at the locating points. When the work requires two settings the

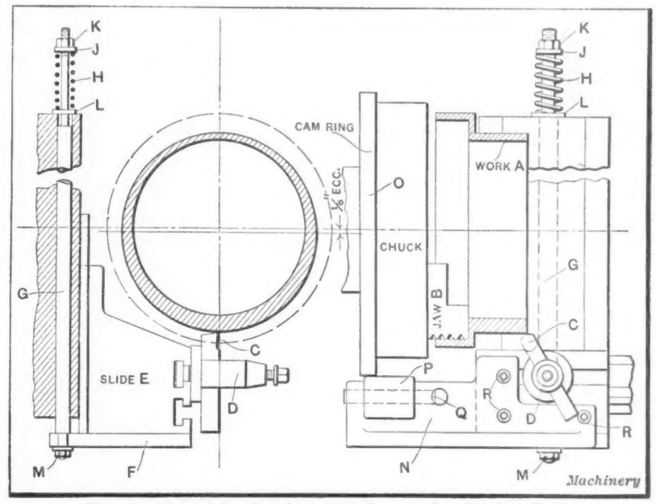


Fig. 2. Eccentric Turning Attachment for Engine Lathe

piece must be carefully located from a previously machined surface which bears a positive and fixed relation to the eccentric portion. The clamping must be rapid and must be so arranged that it will not distort the work. When it is desired to use an eccentric turning device, the following points in design will be found of value.

Points in Design of Eccentric Turning Devices

1. Rigidity. All brackets and castings should be made of ample section not only to withstand the stresses to which they may be subjected but also to deaden the vibration which may be caused by cutting action of the tool. A bracket may be strong enough to perform its functions and yet not have sufficient metal in it to prevent vibration. Proportions of moving shafts should be generous and bearing surfaces of good length.

2. Direction of the cam thrust. This should be such that it tends to throw the tool into the work rather than in a con-

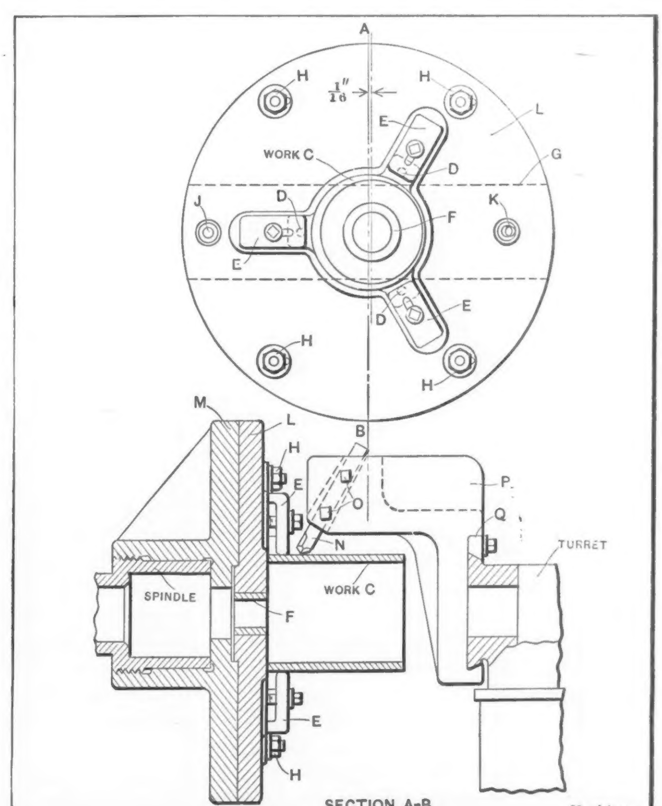


Fig. 3. Eccentric Turning Fixture for Horizontal Turret Lathe

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trary direction. Springs or weights can be arranged to prevent the tool from "digging in." This arrangement is desirable but not absolutely essential, for conditions are sometimes such that the cam must be arranged so that it throws the tool away from the work. When it is found necessary to make it in this way the springs or weights should be made very stiff so that a positive contact with the cam is assured at all times.

3. Proportions of cam roll. In cases where a rolling contact is used, the pin on which the roll revolves should be not more than one third the diameter of the roll. If not so proportioned the friction on the pin, caused by the pressure of the contact with the cam, will be so great that the roll may not always revolve and this will naturally have a tendency to make flat spots in the roll due to unequal wear.

4. Chip protection. All moving parts should be carefully guarded so that chips and dirt will not get in and cause imperfect work.

5. Provision for oil. This matter should be taken care of on the eccentric turning device just as if it were a part of the machine itself, for many a good attachment has been seriously injured by lack of oil. Oil cups are cheap and easily applied and an operator has no excuse for neglecting to oil a fixture when oil cups are in plain sight.

6. Simplicity and economy in cost of attachment. These points should receive due consideration, always bearing in mind the number of pieces to be machined and making the cost in proportion as far as possible.

A number of illustrations of eccentric work are shown and they will be discussed and criticised in this article.

Eccentric Turning on the Engine Lathe

The upper illustration in Fig. 1 shows the simplest problem in eccentric turning which may be met with in ordinary shop practice. The steel eccentric shaft *A* is to be machined so that the smaller end *J* will be eccentric to the larger portion by half an inch. The centers *B* and *C* are first carefully put in at the correct distance from each other, after which the work is placed in the lathe (on the centers *B*) and the entire shaft turned concentric. In turning the portion *J*, the centers *C* are used, the dog *D* being used as the driver. The work revolves on the centers *E* and *F* in the spindle and tailstock of the lathe, and the tool *G* in the cross-slide toolpost *H* is used to do the turning. It is obvious that several cuts are necessary to bring the work down to the proper size. Work which requires machining in this manner is not at all unusual, and this method of handling is familiar to every machinist and toolmaker.

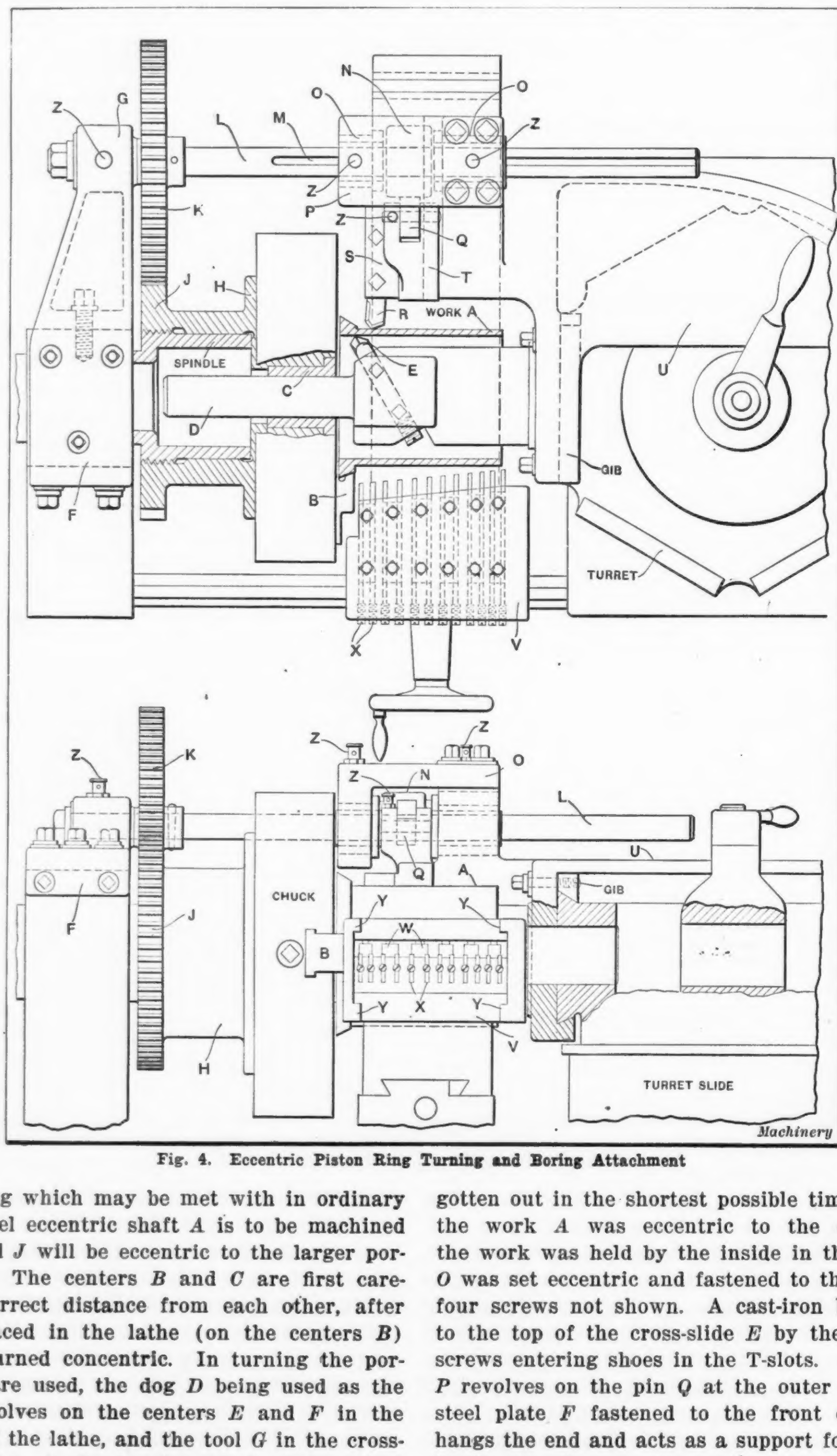


Fig. 4. Eccentric Piston Ring Turning and Boring Attachment

Sometimes work which requires eccentric turning is of such a nature that the use of centers is not desirable. Such an instance is shown at *K* in the lower part of Fig. 1. In this case the flange and the hole *P* are concentric, but the hub *O* is 3/8 inch eccentric. There are several ways in which this piece of work could be handled: It could first be held in a four-jawed chuck by the hub *O*, the jaws being thrown off center until the flange runs approximately true. The flange could then be turned and faced and the hole *P* chucked out and reamed. An eccentric arbor could then be used in the hole and the hub *O* turned on this arbor. This method would require a special arbor with the proper eccentricity. In order to avoid this expense let us consider that we have performed the first operation as mentioned and are now ready for the eccentric turning. By using a four-jawed chuck and holding the work in the jaws *L* by the flange it is a very simple matter to indicate an arbor or stud placed in the hole *P* and set the jaws off center until the desired eccentricity has been obtained.

Eccentric Turning Attachment for the Engine Lathe

The two methods given in Fig. 1 are more suited to work not made in quantities, and may be used in cases where one or two pieces are required. The device shown in Fig. 2 was used for a number of pieces, there being fifty in the lot. This arrangement was applied to an old Pratt & Whitney lathe which had a taper turning attachment at the rear of the bed, this machine being selected because it could be adapted quickly to the work in hand without great expense. This example is given not because it is of great value but simply to call attention to a "makeshift" method of handling a job which was "rush" and which, therefore, had to be gotten out in the shortest possible time. One of the hubs on the work *A* was eccentric to the other by 1/8 inch and the work was held by the inside in the jaws *B*. A cam ring *O* was set eccentric and fastened to the back of the chuck by four screws not shown. A cast-iron bracket *N* was screwed to the top of the cross-slide *E* by the three screws *R*, these screws entering shoes in the T-slots. A hardened steel roller *P* revolves on the pin *Q* at the outer end of the bracket. A steel plate *F* fastened to the front of the cross-slide overhangs the end and acts as a support for the rod *G*, being held in place by the nut and washer at *M*. This rod runs entirely through the carriage and is threaded at its outer end to receive the nut *K*.

A stiff coil spring *H* bears against the two washers *J* and *L*, and serves to keep the slide drawn forward at all times

so that the roll *P* is continually in contact with the cam ring *O*. A tool *C* held in the toolpost *D* serves to turn the eccentric. It will be noted that the cam roll *P* is made long enough to give contact during the required cut.

Eccentric Turning Fixture for a Horizontal Turret Lathe

Packing rings such as are used on automobile gas engines are usually eccentric and these are handled in many cases by an automatic or semi-automatic machine which is provided with some sort of an eccentric turning device. There are instances, however, when the expense of a device of this kind is not warranted by the amount of production required. Fig. 3 is an example of this sort, the rings being required in small quantities. The ring pot *C* is of cast iron and has been previously faced on the back of the lugs, approximately square with the pot proper. Holes have also been drilled at *D* by the use of a jig. The work is located by these three holes on the pins *D* which are fixed in the sliding plate *L*. The three clamps *E* are used to hold the pot firmly, and these clamps are slotted to facilitate rapid removal. The bushing *F* is concentric with the interior of the pot and is used in another operation as a guide for the boring-bar. The plate *L* is tongued at *G* to fit a corresponding groove in the faceplate *M*. This faceplate is well ribbed and is screwed to the spindle. After the boring has been done, the four nuts *H* are loosened, the locating pin *J* is removed from its bushing, and the plate is pushed over until the pin *J* can be pushed "home" in the other bushing *K*. It will be noted that it is not possible to locate the two indexing bushings side by side on account of the small amount of eccentricity, this being only 1/16 inch in this case.

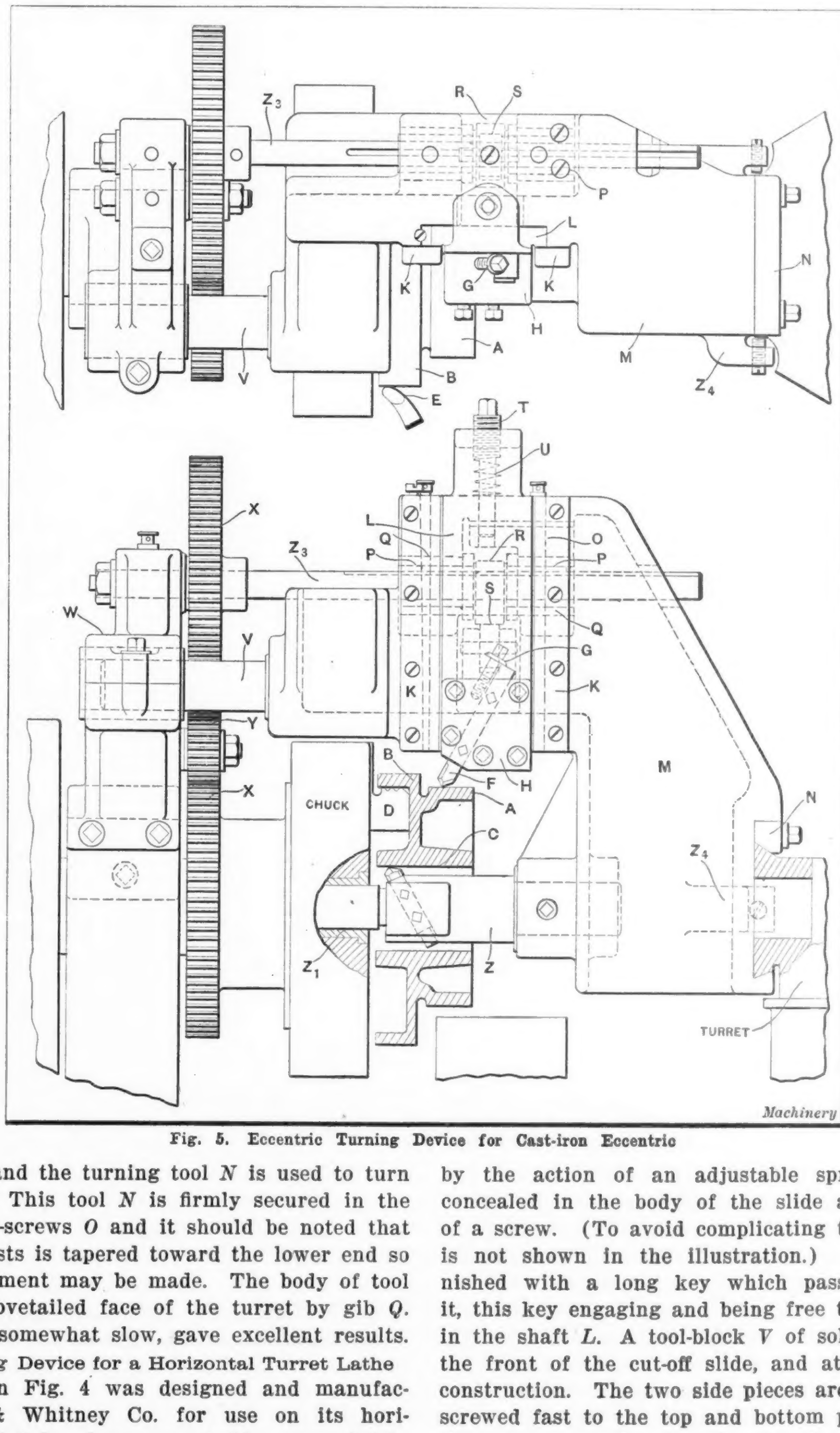


Fig. 5. Eccentric Turning Device for Cast-iron Eccentric

After the plate has been set over, the nuts *H* are tightened and the turning tool *N* is used to turn the eccentric surface. This tool *N* is firmly secured in the body *P* by the two set-screws *O* and it should be noted that the slot in which it rests is tapered toward the lower end so that a swinging adjustment may be made. The body of tool *P* is secured to the dovetailed face of the turret by gib *Q*. This fixture, although somewhat slow, gave excellent results.

Eccentric Ring Turning Device for a Horizontal Turret Lathe

The device shown in Fig. 4 was designed and manufactured by the Pratt & Whitney Co. for use on its horizontal turret lathe, and it has been remarkably successful in the production of eccentric piston rings for gas engine work in a minimum amount of time. The construction of the entire device is such that it may be applied to a standard machine without injuring it for other work. The component parts of the device can be removed quickly from the turret lathe, leaving the machine ready for regular chucking work. A special faceplate *H* is used to hold a three-jawed geared scroll chuck having special jaws *B* which grip the angular flange of the ring pot. This flange is made so that it is concentric with the interior of the pot. The faceplate *H* is furnished at its rear end with a spur gear *J* which meshes with another of the same size *K*. The cast-iron bracket *F* is fastened to the top of the spindle cap and has a hub *G* at its outer end which acts as a bearing for the spline shaft *L*. It will be noted that the gear *K* is pinned to this shaft by a tapered pin. A large cast-iron bracket *U* is fitted to the dovetailed faces of the turret and extends entirely across it, being secured by the gibs shown. A boring-bar of tool steel, having a hardened and ground pilot *D*, is mounted in the turret, and the pilot is guided by a bushing *C* in the chuck. The boring tool *E* sets at an angle of 30 degrees in the bar and is secured by two square-head set-screws. Fine adjustments are obtained by means of the backing-up screw shown. The piloting of the bar in the chuck bushing gives great rigidity.

A steel block *S* holds the tool *R* which does the eccentric turning. This block is mounted on a dovetail slide *T* which has an adjustable taper gib securing it to the outer end of the bracket *U*. A small L-shaped bracket *O* is tongued to the top of a lug on the main bracket and acts as an outboard bearing for the cam quill *N*. This quill has a roll with the correct eccentric turned on it and it is supported at each end in two hardened and ground steel bushings, these bushings being forced into their places in the bracket and lug, respectively. A smaller roll *Q* is mounted on the top of the dovetailed slide and is held constantly in contact with the cam roll by the action of an adjustable spring of heavy section, concealed in the body of the slide and adjusted by means of a screw. (To avoid complicating the drawing this spring is not shown in the illustration.) The cam quill is furnished with a long key which passes completely through it, this key engaging and being free to slide in the spline *M* in the shaft *L*. A tool-block *V* of solid steel is mounted on the front of the cut-off slide, and attention is called to its construction. The two side pieces are tongued at *Y* and are screwed fast to the top and bottom pieces of the tool-block, the tongues serving to take the thrust of the holding-down screws and making for a very rigid construction. A supplementary block is fitted so that it slides freely in the holder and in this block the cutting-off tools *X* are mounted. Fine adjustment is provided in the backing-up screws. The tools themselves are clamped in position by the blocks *W*

which bear along their upper edges and are secured by means of the square-head set-screws in the tool-block cap, two tools being gripped by each block. The cutting ends of these tools are ground to an angle of 5 degrees with the center line of the spindle so that their action in cutting off will be progressive, and the rings will drop off one at a time without breaking. In the spacing of the cutting-off tools an allowance of 0.010 to 0.012 inch is made for grinding the sides of the rings. These tools are very carefully made and surface-ground on the side so that they are a nice push fit in the tool-block slots. Oil cups for the various bearings are shown at Z.

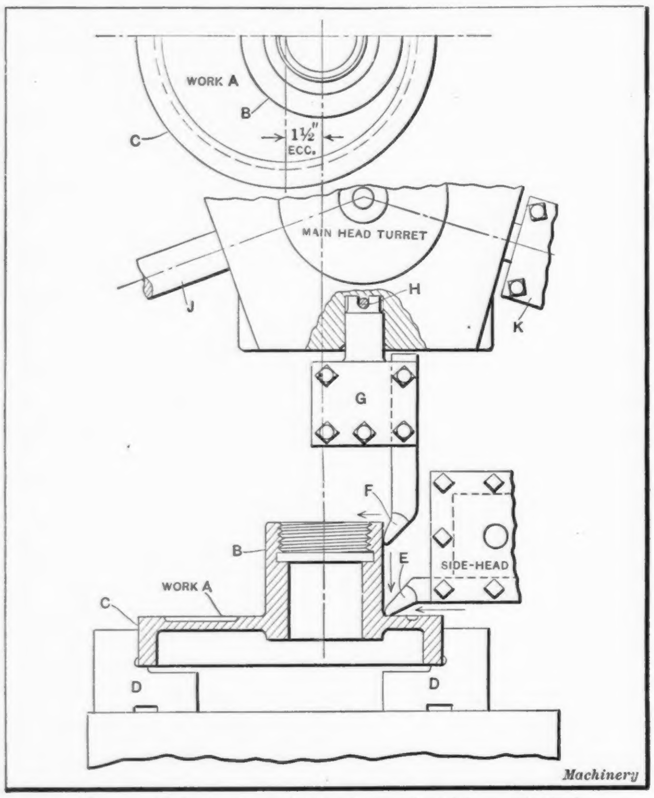


Fig. 6. Method of machining Eccentric Hub on Vertical Turret Lathe

The operation of the device is as follows: As the spindle revolves the spur gear J meshing with K revolves the spline shaft L once while the spindle revolves once, and the quill which is keyed to a sliding fit on the spline shaft revolves the cam roll N, thus forcing the slide T in and out and forming the eccentric on the outside of the pot. As the turret moves forward, it will be seen that the boring tool E is working on the concentric inside while the tool R is in opposition to it on the outside. After the turning and boring have progressed about an inch and a half, the cross-slide feed is thrown into engagement and the cutting-off tools part the rings one by one. A great number of these equipments have been sold by the Pratt & Whitney Co., and have given universal satisfaction.

Eccentric Turning Device for a Cast-iron Eccentric

The cast-iron eccentric shown at A in Fig. 5 has the flange B and the hole C concentric, while the portion A is one half inch eccentric to these surfaces. The work is held by the inside of the flange in the special jaws D, a three-jawed geared scroll chuck being used. The faceplate of this chuck has a spur gear X cut on its rear end. This gear meshes with an idler Y which, in turn, transfers the motion to the upper gear X, this being of the same diameter as the faceplate gear. The gear Y is mounted on a stud which has a bearing in the bracket W, this bracket being mounted on the spindle cap. The shaft Z_3 on which the upper gear X is mounted, is splined to receive a key which extends the entire length of the cam quill P. This key is fitted so that it has an easy sliding fit in the shaft. The bracket M is of cast iron, box section, and it is mounted on the dovetail face of the turret and secured by the gib N. The two lugs Z_4 each contain a set-screw which is used partly to adjust the heavy bracket into position when assembling, and partly to prevent its working loose on account of the jar incident to the shock caused by indexing the turret. The piloted boring-bar Z is mounted in a boss in the bracket and is used to bore the hole in the hub while the eccentric turning is being done. The bushing Z_1 in the chuck acts as a guide for the bar and also assists in preventing chatter. It is well to note that the boring tool stands in a vertical plane. The bracket has a pilot V at its forward end and this enters a bushing in the spindle cap bracket. The hub or boss which holds it is split and is clamped tightly on the bushing by means of the collar head screw shown. The tool F which turns the eccentric is mounted in a steel block H and it is backed up by the screw G.

After the rough-turning operation is over, the tool F is removed and a finishing tool substituted for it, the backing-up screw acting as a gage or stop against which the ends of the tools rest so that diameters can be duplicated without trouble. The boring-bar also can be quickly removed and the finishing bar substituted for it by simply loosening the screw which holds it in place in the hub. The tool-block is secured to the slide L by the screws shown and the slide is held in place by the two strap gibs K. A taper gib with a backing-up screw is provided to take up wear on the slide. A projecting lug at the top of the slide provides a means of holding the adjusting screw T which is used to stiffen the heavy coil spring which holds up the slide. The bracket O which furnishes one of the bearings for the cam quill is tongued on its upper surface and is screwed fast to a projecting portion of the main bracket. The two ends P of the cam quill are carried in bushings Q. The cam roll R is ground to the correct eccentricity and controls the movement of the slide through the contact of the roller S which is mounted between the lugs shown on the back of the slide. A cored opening in the main bracket permits the free passage of the lugs without interference.

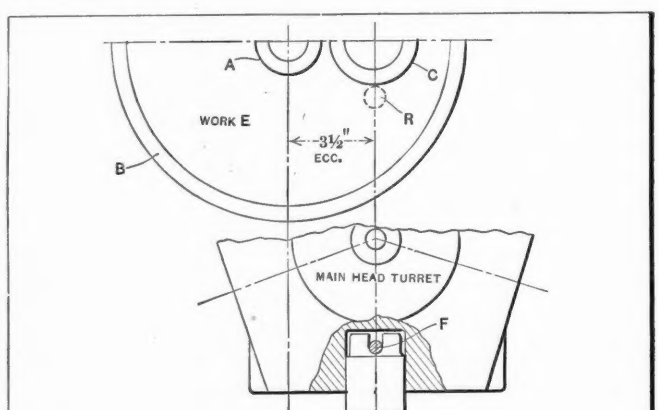


Fig. 7. Eccentric Turning Fixture for Vertical Turret Lathe

During the operation of the eccentric turning device and the boring of the hole (power feed being thrown in for this work), the tool E which is held in a regular toolpost on the front of the cut-off slide is fed by hand along the concentric portion of the casting B and is also used for facing the end. While the finish turning and boring are being accomplished by the eccentric device, a finishing tool on the rear of the cut-off slide is used to finish the surface B (this tool is not

shown on account of lack of space). Oilers are provided for all bearings. It may be noted that the operations of turning eccentric and concentric and boring the concentric hole are all going on at the same time. The device is somewhat top-heavy and rather expensive, but it is capable of handling a number of pieces of varying eccentricity by substituting cam quills of the proper "throw," and making the necessary boring-bar adjustments. The coil spring *U* is of 3/16-inch stock, square section, and is very stiff, as it has to support the weight of the slide and keep the tool from pulling in. Attention is called to the fact that the action of the cam roll is such that it forces the tool to take the correct path so that an absolutely correct eccentric is formed.

Machining an Eccentric Hub on the Vertical Turret Lathe

The work shown at *A* in Fig. 6 has a hub *B* which is eccentric to the gear *C* on the outer rim by 1½ inch. In the machining of this casting it was first held by the inside of the flange in a three-jawed chuck having special jaws permitting the edges of the flange to be faced. In the setting shown in the illustration, a four-jawed chuck was utilized, the jaws *D* being set off center sufficiently to produce the desired eccentric on the hub. As there were only a few of these pieces to be machined the expense of an eccentric turning device was not warranted, so that this method, although somewhat slow, was considered the best for the purpose. Two of the four jaws were left set after the first piece had been machined so that in placing the other pieces in position, these two jaws acted somewhat like a V, and greatly facilitated the setting up. A conical plug was used in one of the turret faces to assist in approximating the cored center of the hub. This plug is not shown in the illustration but its action will be readily apparent. The tool *F* is mounted in a tool-holder *G*, the stem of which enters the turret hole and is driven by the pin *H*. This tool is obviously used for rough turning and facing the hub. While this operation is going on, the tool *E* in the side-head is used for facing. A boring-

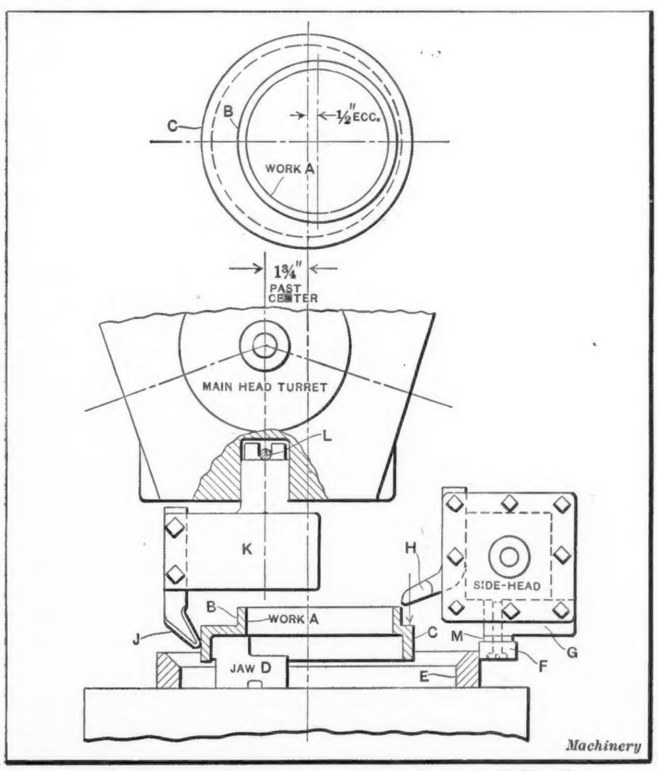


Fig. 8. Eccentric Turning by means of Eccentric Guide Ring

bar *J* is next used to bore the hole and while this is being done a finishing tool (not shown), in the side-head turret, is swung into place and is used for finish facing and turning the hub. A tool-holder *K* in the main head turret contains a grooving tool for the thread recess, while a thread chasing bar is used to cut the thread.

Eccentric Turning Fixture for the Vertical Turret Lathe

The piece of work shown at *E* in Fig. 7 represents a condition somewhat out of the ordinary, in that the eccentric throw is 3½ inches. By referring to the upper part of the illustration it will be noted that the small hub *A* and the rim *B* are concentric, while the hub *C* is eccentric, the amount previously stated. As there were a number of these pieces to be machined, and as the eccentric throw was so great, it was considered expedient to design a fixture on which they could be handled. Previous to the setting shown, the work had been machined on the periphery *B*, the edges of the flange had been faced, together with the hub, and the hole in

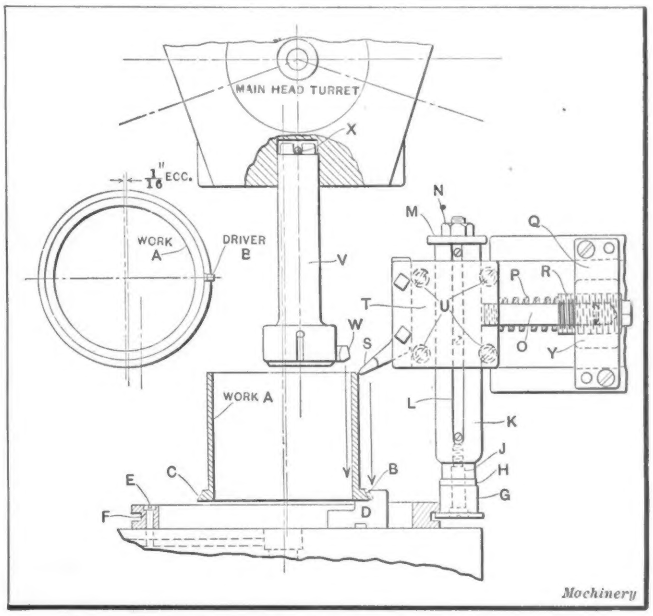


Fig. 9. Device for boring and turning Eccentric Ring Casting

the hub *A* had been bored and reamed. The body of the fixture *H* on which the piece is now held is of cast iron and is centered on the table by means of the plug *K*, while it is held in position by the T-bolts *L*. A hardened and ground steel plug *J* is located at the proper distance from the center of the table and on it the work locates. A plug *R*, shown in the upper view, strikes against the larger hub and acts both as a locater and driver for the work. The three clamps *N* are drawn down on the edge of the flange by the screws *M*, the lugs *O* on the fixture body being used to support the outer end. These clamps are of the type usually termed U-clamps so that they may readily be pulled back out of the way when releasing the work. A pocket *Q* under the large hub allows the end of the boring-bar to pass through the hole. An opening *P* allows easy removal of chips. The boring-bar *D* fits the turret hole and is driven by the pin *F* in the turret. This bar is made by the Bullard Machine Tool Co., and is provided with a set of slip cutters and reamers for any size hole within its capacity. (The construction of the bar was fully described in MACHINERY, March, 1914.) The tool *G* in the side-head turret is used for facing the hub during the boring operation.

Fig. 8 shows a makeshift arrangement for machining the work *A* on a vertical turret lathe. In this instance the portion *B* is eccentric to *C* ½ inch.

The work is held by the inside in the jaws *D* of a three-jawed table, so that the portion *C* is concentric with the center of the table. A steel ring *E* is bolted eccentrically to the center of the table by the same amount as the desired eccentricity on the work. This ring is beveled on the inside to allow clearance for the turning tool *J*. This tool is held in a special holder *K* which has a shank running up into the turret hole and there driven by a pin *L* in the usual manner. A hardened and ground tool steel roll *F* is mounted on a shouldered screw which enters the rectangular holder *G*, a thrust washer *M* being interposed between the moving surfaces. The two sides of the roll holder *G* are ground parallel, so that the roll will always be in a position parallel to the outside of the cam *E*. It will be seen that if this roll were not so located, there might be a possibility of cramp developing when pressure was applied. The tool *H* is, obviously, used for turning the eccentric. Attention is called to the fact

that in the use of this device the operator's constant attention is necessary in order to produce accurate work. The cam roll *F* must be forced against the cam *E* by the pressure of the feed lever crank on the side head, and the pressure applied must be sufficient to overcome any tendency of the pressure of the cut to push the roll away from the cam. It can, therefore, be readily seen that the operator's task is by no means easy in this instance.

Boring and Turning an Eccentric Ring Pot on the Vertical Turret Lathe

The detail view to the left in Fig. 9 shows a plan of the ring pot *A*, the outer surface of which is eccentric to the hole by 1/16 inch. Attention is called to the driver *B* which obviates the necessity of a great amount of pressure being used in setting up the jaws to hold the work, this lug being twisted around when placing the piece in position, so that it comes against the side of the jaw and greatly assists in driving the work. The jaws *D* are formed to the same bevel as the flange and the table is of the three-jawed type. The boring-bar *V* is of the same type as that previously described, being driven by the pin *X* in the turret. The tool *W* is, obviously, used for boring the concentric interior of the ring pot. A

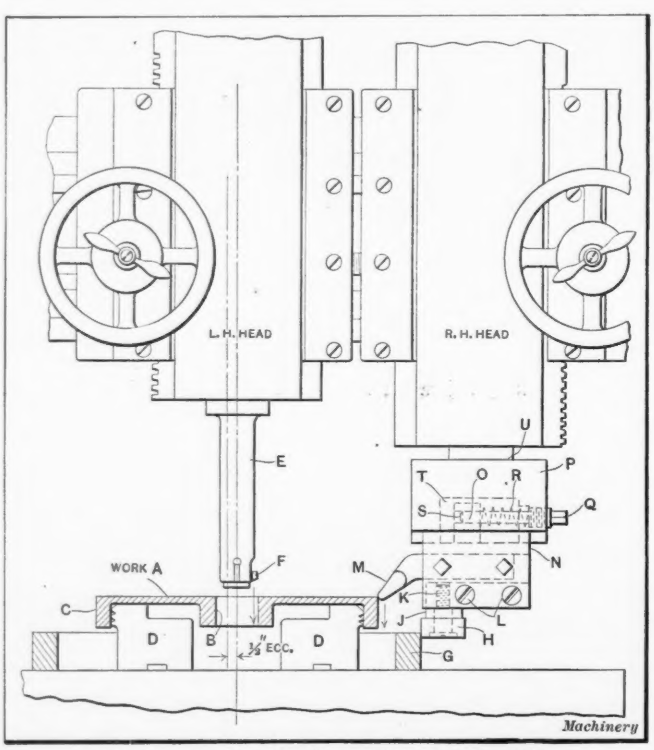


Fig. 10. Eccentric Turning on Vertical Boring Mill

special cam ring having a groove *F* on its periphery is eccentrically set on the table and secured in position by the screws *E*. These screws pull up on shoes placed in the table T-slots. A special side-head *T* is used in connection with this device (the regular side-head turret being removed), and it is held securely in position by the four screws *U* which are tapped into it through the rear of the slide.

A hardened and ground tool steel bar *K* passes through this special block and is prevented from turning by the key *L*. A nice sliding fit is made between the bar and the block and the upper part of the bar is provided with a collar *M* and a nut *N*, in order to prevent its dropping out of position when the side-head is pulled back. The lower end of the bar is fitted with a shouldered screw *J* on which the flange roller *G* revolves. A thrust washer *H* is interposed between the roll and the end of the bar. A bracket *Q* having a shape somewhat in the form of a U is fastened to the side-head saddle, and bridges across the slide in the manner shown. On the under side of the bracket is the boss *Y* which is tapped out for the adjusting screw *R*. The pin *O* is screwed into the side-head and acts as a guide to keep the spring *P* from buckling. This spring is of 1/4 inch square section and is very stiff. It will be noted that the pressure of the spring can be regulated to a nicety by means of the screw *R*. The tool *S* is used for turning the eccentric and it is held in place by the two screws shown.

In the operation of this device the side-head slide is moved forward by the pressure of the spring so that the roll *G* is kept in contact with the cam. The down feed of the side-head is then thrown into engagement and the tool *S*, following the movement of the cam, produces the eccentric on the outside of the ring pot. As the side-head moves downward the flange on the cam roll strikes the lower part of the groove *F* in the cam and allows the side-head to slip easily downward on the bar *K*. While the outside turning is in process the boring tool *W* in the main head turret bores the interior of the pot concentric. The two tools *W* and *S*, acting in opposition to each other, tend to eliminate vibration in the shell and also assist in maintaining the sizes.

Eccentric Turning on the Vertical Boring Mill

The work *A* shown in Fig. 10 is of cast iron and has a hole *B* 1.2 inch eccentric to the rim *C*. The machine on which this work is done is a vertical boring mill having two heads. The work is gripped by the inside of the rim in a four-jawed chuck, two of the jaws *D* being shown in the illustration. These jaws are special and are set off center sufficiently to bring the hole *B* in the center of the table. A boring-bar *E* with a set of slip cutters *F* is used in the left-hand head to bore and ream the hole. This operation, however, does not take place while the outside turning is going on, as the boring speed would be too slow to be profitable. A tool-holder with a facing tool in it is used in place of the bar to face across the web while the eccentric turning is taking place. The tool-holder is then slipped out and the bar *E* placed in position, after which the table is speeded up and the hole bored.

A cam ring *G* is fastened to the table in the proper position to produce the correct eccentricity. A special device is mounted in the right-hand head, the body *P* being of steel and having a shank *U* which enters the hole in the ram. The lower portion of this block is dovetailed and to it the sliding tool-holder *N* is fitted. The lug *O* enters a recess in the block *P* and gives a surface against which the spring *R* thrusts. This spring is of heavy section and is adjusted by means of the screw *Q*, the end of which is turned down to fit the inside of the spring and prevent it from buckling. The end *S* pilots in a hole in the lug. The cam roll *H* is of tool steel hardened and ground and it revolves on the cylindrical portion of the shouldered screw *K*, the thrust washer *J* being interposed between the roll and the block. The holder is rectangular in shape and accurately fits a slot in the slide *N*. The two screws *L* hold it in place and incidentally tie the open side of the slide together. The tool *M* enters the upper portion of the slot and is held in place by the two screws shown. It can readily be seen that the action of the spring *R* tends to force the slide *N* forward, thereby keeping the roll *H* continually in contact with the cam *G*. As the tool *M* is held in the slide *N* it is obvious that it will follow the path generated by the roll and produce the desired eccentric.

* * *

Notwithstanding the fact that high-speed steel has effected a revolution in machine shop practice generally, it is claimed that all the improvements in tool steels made in the last twenty years have not displaced certain brands of carbon steel for some classes of metal cutting. Among them is the turning of chilled cast-iron rolls. Carbon steel still holds its own. High-speed steel that gives good service on the toughest alloy steels falls down completely in roll turning. The cutting speeds are so low—from one to three feet per minute—that the red hardness characteristic of high-speed steel is not developed, and the superior hardness of carbon steel at low temperatures enables it to stand up to the work.

* * *

According to the latest statistics, there are approximately 1,140,000 automobiles in use in the United States. New York state has 133,000 automobiles, Illinois, 95,000 and Ohio 87,000. Pennsylvania comes fourth with 79,000 and Iowa fifth with 77,000. The smallest number of cars is in Nevada, where there are about 1150; Wyoming has 1600 and New Mexico, 2000 cars.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

LATHES FOR CUTTING THREADS OF COARSE LEAD AND ODD PITCH

The article in the April number of MACHINERY by Russell K. Annis describing an ingenious homemade device for cutting a spiral on a Lodge & Shipley lathe, and the discussion of the same matter by Guy H. Gardner in the June number, indicate that special thread gearing for lathes may be a suitable topic for general consideration. Those two articles describe methods of cutting what are in the true meaning of the word spirals, that is, plane curves. The other Lodge & Shipley equipments shown by the accompanying illustrations were designed for chasing coarse-pitch screws and worms (often spoken of as spirals) and may be of further interest.

Fig. 1 illustrates the rear of a 22-inch by 14-foot patent-head lathe and shows the additional special lead-screw at the back of the bed through which the coarse leads are obtained. This lathe is also provided with regular quick-change gearing, lead-screw, apron, etc., at the front for standard feeds and threads. When the coarse-pitch threading attachment is in use, the headstock back-gears are thrown into mesh and the drive is from the large back-gear through the change gears mounted on the bracket at the rear of the bed to the special lead-screw. This screw is solidly supported at frequent intervals by long shoes bolted to pads on the back of the bed.

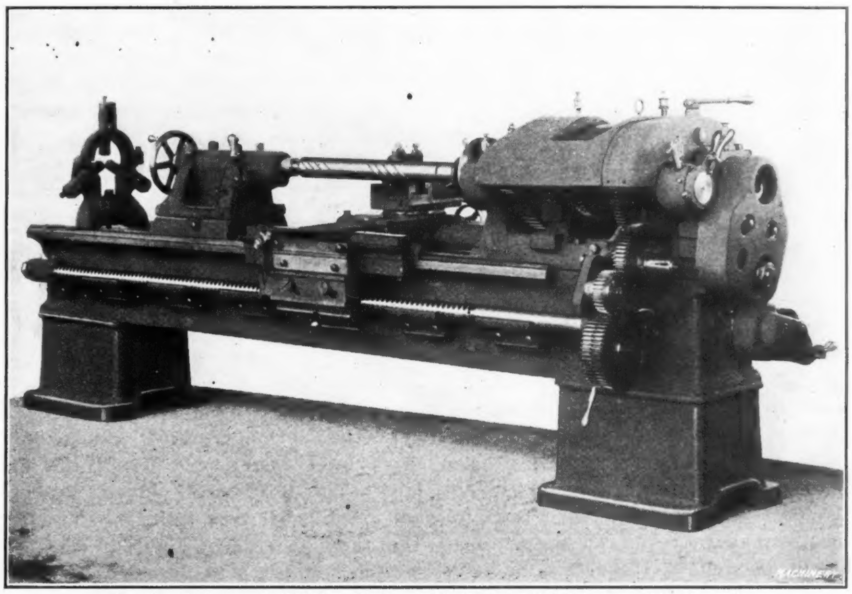


Fig. 1. Lodge and Shipley Lathe with Coarse-pitch Chasing Attachment

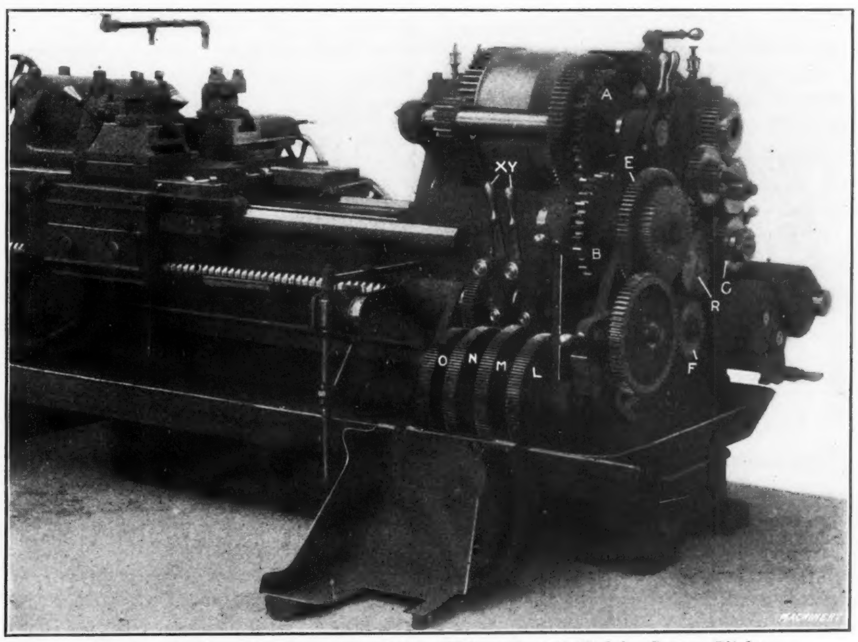


Fig. 2. Chasing Attachment for Metric, Whitworth and Module Coarse Pitches

A long half-nut on the back of the carriage is so arranged that it may be raised or lowered by a cam so as to clear or engage the threads of the screw. This cam, which is clearly seen in the illustration, is operated by a handwheel at the front of the apron, which transmits motion through a pinion and sector located on the left carriage wing. For leads from 1/32 inch to 2 inches, the regular quick-change gears and screw at the front of the lathe are used. Leads from 2 inches to 15 inches are obtained by the coarse-pitch attachment at the back.

Fig. 2 shows the thread gearing of another 22-inch lathe which is arranged for chasing both standard and coarse-pitch threads, but with the addition to the coarse-pitch threading attachment just described of gearing to permit cutting the coarse pitches either in metric or Whitworth systems or module pitches in either. By "module pitches" we mean pitches being a multiple of π (that is, 3.1416) times the lead expressed either in millimeters or inches; a module pitch would be necessary for a worm which had to mesh with a gear the teeth of which were cut according to diametral pitch measurement. This lathe also has regular quick-change gears and a lead-screw for standard pitches. The initial driving gear *E* of the coarse-pitch threading attachment may be driven at two rates of speed. When driving from the sliding tumbler shaft through gears *C* and *R*, one set of leads is obtainable at the rear screw, coarser than the standard leads of the regular quick-change gearing. When the drive to gear *E* is from the back-gear shaft through gears *A* and *B*, the rear screw revolves much faster relative to the spindle than under the condition just named and, therefore, a set of still coarser leads will be obtained.

Change gears for different pitches may be placed on the quadrant below gear *E*. The same gears are used for both the metric and Whitworth leads because the translating gearing is placed between the quadrant and the screw. The four pairs of gears to the left of the quadrant comprise the metric and the module translating gears. When levers *X* and *Y* are in the positions shown, the four pairs of gears *L*, *M*, *N* and *O* are not operative, and the drive is direct from gear *F* through a long sleeve to the coarse-pitch screw. This gives coarse metric pitches because the screw has metric lead. Throwing handle *X* to the right engages the module translating gears *N* and *O*, and if handle *Y* remains as shown in the illustration, this would give module metric leads. Throwing handle *Y* to the right engages the metric to the Whitworth translating gears *M* and *L*; this will result in chasing Whitworth pitches if lever *X* is to the left, and Whitworth module pitches if lever *X* is to the right. Gear covers are provided to enclose all of the gearing.

Cincinnati, Ohio — HENRY M. WOOD

CLOTH SCREENS FOR DRAFTING-ROOM WINDOWS

Few of the drafting-room problems are as serious as the elimination of dust and dirt from the boards, tables and drawings while maintaining a circulation of fresh air through open windows. Especially in the city shops and railroad offices is this most serious, where not only fine dust fills the air at all times but cinders and large matter is continually sifting through open windows onto drawings and, on account of its sooty condition, is not so easily or cleanly removed as the finer particles of dust.

While an ideal system of ventilation, without dust, is seldom secured except at a large expense, the following simple scheme can be depended on to give satisfactory service in eliminating the greater part of dust and soot from drafting offices and, at the same time furnishes practically the same circulation of air as the open windows. Frames, made to fit the window opening, similar in every respect to ordinary screen frames, covered with cheese cloth on both sides and placed in the window the same as wire screens, serve as an air strainer. The loose texture of the cloth permits the uninterrupted circulation of air and its gauzy strands strain out the soot and dust from the incoming air. Another feature of their use is that they eliminate the strong drafts. The space between the outer covering and the inner serves to further promote the free circulation of air and the thin inner covering still further eliminates the dust and dirt.

Such screens may be used either at the top or bottom of the window. They do not affect the lighting value of the open space materially, unless they are allowed to become too dirty and discolored, and they should be renewed when excessive dust has accumulated in the strands. It is desirable that the cloth used should be pre-shrunk and stretched slightly on the frame, as loosely covered openings tend to stop the free circulation of air. These screens can be installed at a slight expense and should be well worth the cost.

Winter Hill, Mass. FRANK H. JONES

FULL-SIZED DRAWINGS

Draftsmen who have had little or no practical experience in the pattern shop cannot understand why patternmakers in general so often "kick" against working from a reduced scale drawing. I have just completed four patterns made from a reduced scale drawing. Three of these drawings I was obliged to re-draw full size, to guard against mistakes in both shape and dimensions. A great many pattern shop foremen insist on reproducing all reduced drawings to full size; however, this should not be done by the patternmaker, as the draftsman has every convenience in the drawing-room, and this is where drawings should be made full size when possible.

If conditions call for a reduced drawing do not try to put every detail piece on one sheet in order—as our draftsman puts it— "to save tracing cloth and space in the filing drawer." Never offer this economy "stunt" to a patternmaker as an excuse for not drawing full scale, especially when he is struggling with one of these drawings in a shop where the patternmaker must work from the drawings furnished by the drawing office. I have worked in a number of shops where this is the rule, and it's a mighty poor rule.

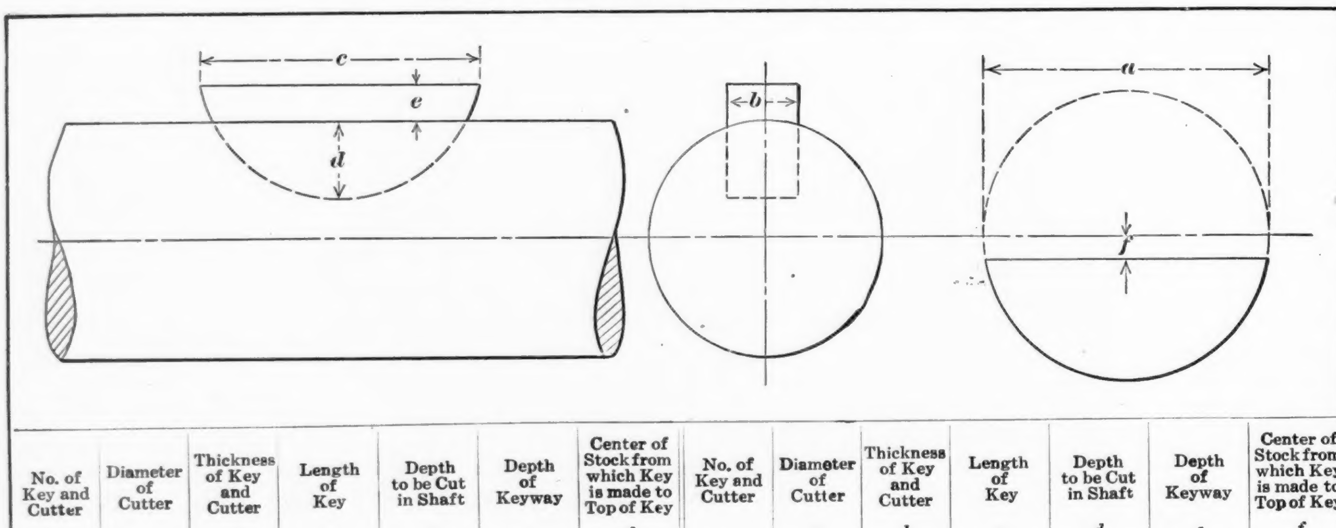
Give me a shop where the drawing—when it's possible—is made full size. Past experience has proved to me that in this shop the work is turned out at a low cost and with fewer mistakes in the drafting-room pattern shop and machine shop.

Detroit, Mich. JOHN GREEN

DIMENSIONS OF WOODRUFF KEYS

In the November, 1907, number of MACHINERY two data sheets were published giving the dimensions of Woodruff keys. The information given in these tables was undoubtedly useful, but they failed to show the depth to be milled in the shaft to receive different sizes of Woodruff keys. The writer had occasion to use this information, and being unable to find it, Tables I and II were compiled. These tables

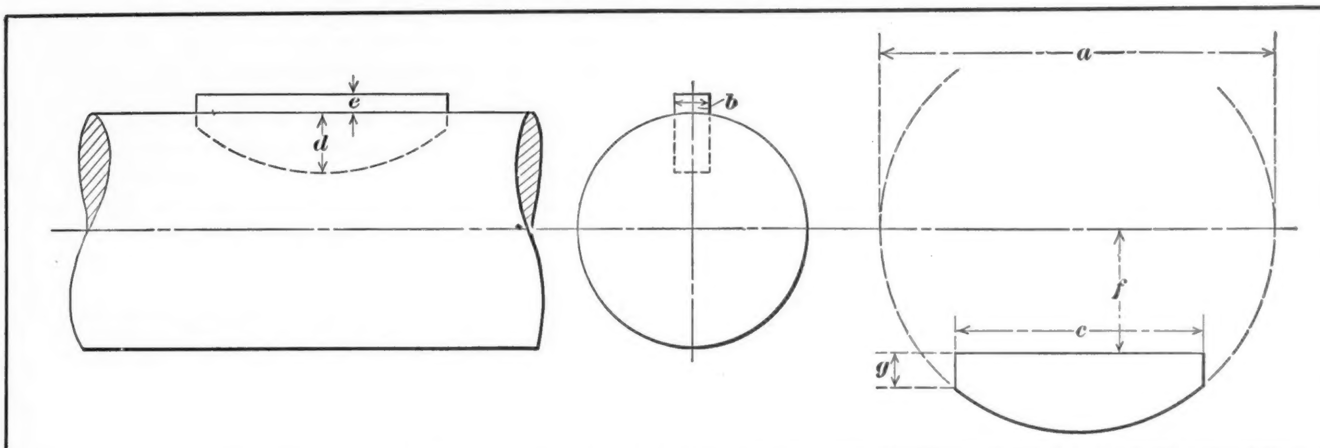
TABLE I. DIMENSIONS OF WOODRUFF KEYS



No. of Key and Cutter	Diameter of Cutter *a*	Thickness of Key and Cutter *b*	Length of Key *c*	Depth to be Cut in Shaft *d*	Depth of Keyway *e*	Center of Stock from which Key is made to Top of Key *f*	No. of Key and Cutter	Diameter of Cutter *a*	Thickness of Key and Cutter *b*	Length of Key *c*	Depth to be Cut in Shaft *d*	Depth of Keyway *e*	Center of Stock from which Key is made to Top of Key *f*
1	1/2	1/16	1/2	0.172	1/32	3/64	B	1	5/16	1	0.282	5/32	1/16
2	1/2	3/32	1/2	0.157	3/64	3/64	16	1 1/8	3/16	1 1/8	0.391	3/32	5/64
3	1/2	1/8	1/2	0.141	1/16	3/64	17	1 1/8	7/32	1 1/8	0.375	7/64	5/64
4	5/8	3/32	5/8	0.203	3/64	1/16	18	1 1/8	1/4	1 1/8	0.359	1/8	5/64
5	5/8	1/8	5/8	0.187	1/16	1/16	C	1 1/8	5/16	1 1/8	0.328	5/32	5/64
6	5/8	5/32	5/8	0.172	5/64	1/16	19	1 1/4	3/16	1 1/4	0.454	3/32	5/64
7	3/4	1/8	3/4	0.250	1/16	1/16	20	1 1/4	7/32	1 1/4	0.438	7/64	5/64
8	3/4	5/32	3/4	0.235	5/64	1/16	21	1 1/4	1/4	1 1/4	0.422	1/8	5/64
9	3/4	3/16	3/4	0.219	3/32	1/16	D	1 1/4	5/16	1 1/4	0.391	5/32	5/64
10	7/8	5/32	7/8	0.297	5/64	1/16	E	1 1/4	3/8	1 1/4	0.360	3/16	5/64
11	7/8	3/16	7/8	0.281	3/32	1/16	22	1 3/8	1/4	1 3/8	0.469	1/8	3/32
12	7/8	7/32	7/8	0.266	7/64	1/16	23	1 3/8	5/16	1 3/8	0.437	5/32	3/32
A	7/8	1/4	7/8	0.250	1/8	1/16	F	1 3/8	3/8	1 3/8	0.406	3/16	3/32
13	1	3/16	1	0.344	3/32	1/16	24	1 1/2	1/4	1 1/2	0.516	1/8	7/64
14	1	7/32	1	0.329	7/64	1/16	25	1 1/2	5/16	1 1/2	0.485	5/32	7/64
15	1	1/4	1	0.313	1/8	1/16	G	1 1/2	3/8	1 1/2	0.454	3/16	7/64

Machinery

TABLE II. DIMENSIONS OF WOODRUFF KEYS



No. of Key and Cutter	Diameter of Cutter	Thickness of Key and Cutter	Length of Key	Depth to be Cut in Shaft	Depth of Keyway	Center of Stock from which Key is made to Top of Key	Width of Flat	No. of Key and Cutter	Diameter of Cutter	Thickness of Key and Cutter	Length of Key	Depth to be Cut in Shaft	Depth of Keyway	Center of Stock from which Key is made to Top of Key	Width of Flat
	a	*b*	*c*	*d*	*e*	*f*	*g*		*a*	*b*	*c*	*d*	*e*	*f*	*g*
126	$2\frac{1}{8}$	$\frac{3}{16}$	$1\frac{3}{8}$	0.313	$\frac{3}{32}$	$\frac{21}{32}$	$\frac{5}{32}$	R	$2\frac{3}{4}$	$\frac{1}{4}$	$2\frac{5}{16}$	0.625	$\frac{1}{8}$	$\frac{5}{8}$	$\frac{1}{8}$
127	$2\frac{1}{8}$	$\frac{1}{4}$	$1\frac{3}{8}$	0.281	$\frac{1}{8}$	$\frac{21}{32}$	$\frac{5}{32}$	S	$2\frac{3}{4}$	$\frac{5}{16}$	$2\frac{5}{16}$	0.594	$\frac{5}{32}$	$\frac{5}{8}$	$\frac{1}{8}$
128	$2\frac{1}{8}$	$\frac{5}{16}$	$1\frac{3}{8}$	0.250	$\frac{5}{32}$	$\frac{21}{32}$	$\frac{5}{32}$	T	$2\frac{3}{4}$	$\frac{3}{8}$	$2\frac{5}{16}$	0.562	$\frac{3}{16}$	$\frac{5}{8}$	$\frac{1}{8}$
129	$2\frac{1}{8}$	$\frac{3}{8}$	$1\frac{3}{8}$	0.219	$\frac{3}{16}$	$\frac{21}{32}$	$\frac{5}{32}$	U	$2\frac{3}{4}$	$\frac{7}{16}$	$2\frac{5}{16}$	0.532	$\frac{7}{32}$	$\frac{5}{8}$	$\frac{1}{8}$
26	$2\frac{1}{8}$	$\frac{3}{16}$	$1\frac{23}{32}$	0.437	$\frac{3}{32}$	$\frac{17}{32}$	$\frac{3}{32}$	V	$2\frac{3}{4}$	$\frac{1}{2}$	$2\frac{5}{16}$	0.500	$\frac{1}{4}$	$\frac{5}{8}$	$\frac{1}{8}$
27	$2\frac{1}{8}$	$\frac{1}{4}$	$1\frac{23}{32}$	0.406	$\frac{1}{8}$	$\frac{17}{32}$	$\frac{3}{32}$	30	$3\frac{1}{2}$	$\frac{3}{8}$	$2\frac{7}{8}$	0.750	$\frac{3}{16}$	$\frac{13}{16}$	$\frac{3}{16}$
28	$2\frac{1}{8}$	$\frac{5}{16}$	$1\frac{23}{32}$	0.375	$\frac{5}{32}$	$\frac{17}{32}$	$\frac{3}{32}$	31	$3\frac{1}{2}$	$\frac{7}{16}$	$2\frac{7}{8}$	0.718	$\frac{7}{32}$	$\frac{13}{16}$	$\frac{3}{16}$
29	$2\frac{1}{8}$	$\frac{3}{8}$	$1\frac{23}{32}$	0.344	$\frac{3}{16}$	$\frac{17}{32}$	$\frac{3}{32}$	32	$3\frac{1}{2}$	$\frac{1}{2}$	$2\frac{7}{8}$	0.687	$\frac{1}{4}$	$\frac{13}{16}$	$\frac{3}{16}$
R_x	$2\frac{3}{4}$	$\frac{1}{4}$	2	0.469	$\frac{1}{8}$	$\frac{25}{32}$	0.1625	33	$3\frac{1}{2}$	$\frac{9}{16}$	$2\frac{7}{8}$	0.656	$\frac{9}{32}$	$\frac{13}{16}$	$\frac{3}{16}$
S_x	$2\frac{3}{4}$	$\frac{5}{16}$	2	0.437	$\frac{5}{32}$	$\frac{25}{32}$	0.1625	34	$3\frac{1}{2}$	$\frac{5}{8}$	$2\frac{7}{8}$	0.625	$\frac{5}{16}$	$\frac{13}{16}$	$\frac{3}{16}$
T_x	$2\frac{3}{4}$	$\frac{3}{8}$	2	0.406	$\frac{3}{16}$	$\frac{25}{32}$	0.1625	35	$3\frac{1}{2}$	$\frac{11}{16}$	$2\frac{7}{8}$	0.593	$\frac{11}{32}$	$\frac{13}{16}$	$\frac{3}{16}$
U_x	$2\frac{3}{4}$	$\frac{7}{16}$	2	0.375	$\frac{7}{32}$	$\frac{25}{32}$	6.1625	36	$3\frac{1}{2}$	$\frac{3}{4}$	$2\frac{7}{8}$	0.562	$\frac{3}{8}$	$\frac{13}{16}$	$\frac{3}{16}$
V_x	$2\frac{3}{4}$	$\frac{1}{2}$	2	0.344	$\frac{1}{4}$	$\frac{25}{32}$	0.1625	..	..	..	...	.....	..	..	..

Machinery

are the same as those published in MACHINERY in 1907, except that they give the depth to be milled in the shaft and also the dimensions of new sizes of Woodruff keys which have been brought out since 1907. In milling the shaft to receive a Woodruff key, the shaft is brought against the cutter until a flat of the same width as the thickness of the cutter is formed; the cutter is then fed into the shaft to the required depth.

Indianapolis, Ind. FRANK E. SCHULTZ

OVERHEAD COST

What is "overhead"? It is something we pay for and for which we get the money from the customer afterward; or else we get it from the customer first and pay for it afterward. It is an unavoidable expense and nothing is a success if it is ignored, but it must be repressed and kept as unobtrusive as possible. The time has passed when any employer expects to cut wages or even to maintain them at the present level. On the contrary, the various payment schemes, with which all of us are more or less familiar, have been devised with the intent of encouraging the workman to earn more. Likewise the purchasing agent cannot hope for great, if any, reductions in the price of the material he buys, as it is largely affected by the cost of the labor entering into it.

The management can, however, very profitably study "overhead," and I venture to say there is not yet any business so perfectly managed as to render this study profitless. Efficiency consists not only in "speeding up" production, but also in "speeding down" non-production. We hear a great deal recently of the uselessness of "interlocking" directorates, but in many plants there is equally useless "interlocking" work. But at a casual glance every one seems busy and no one has any too much time to ascertain of just what this apparent industry consists. For example, the inspection department's rejections often cover minor defects which affect neither the utility nor the selling value of an article, yet the business must bear the expense of correcting the defect or consigning the material to the scrap heap.

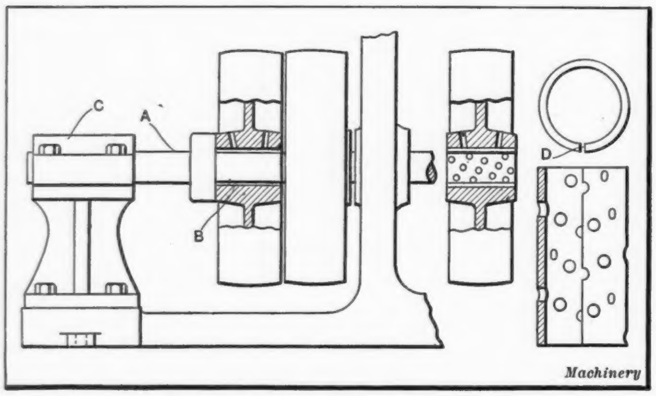
In our enthusiasm for scientific management we are too prone to engulf ourselves in a vast amount of red tape in putting work through the shop; and not infrequently we find material halted because a delivery slip has been lost, those who are responsible being more interested in proving that someone else lost it than in sending the work merrily on its way. Perhaps fixed charges are not so easily reduced, it being necessary to lay out considerable money, for instance, in order to obtain even a moderate reduction in insurance rates. But power is full of possibilities, and if any one has an opportunity to profit from the suggestion box, the engineer is that one. I have touched on only a few points, and but lightly on those; but this phase of manufacturing is as important as increased skill and labor saving invention.

Jersey City, N. J. H. D. MURPHY

BUSHING FOR A WORN LOOSE PULLEY

The accompanying illustration shows a method which we adopted some time ago in repairing a loose pulley which gave trouble through chattering. The shaft *A* on which this pulley was mounted was in such a position that considerable difficulty would have been experienced in removing it from the machine. As the bearing *B* was worn nearly 1/32 inch from the original size—although comparatively round—it appeared that the prevention of play between the shaft and pulley would be a difficult matter. Owing to wear of the shaft and pulley, this play amounted to considerably over 1/16 inch, the pulley being rather more badly worn than the shaft.

The method of procedure which we finally adopted was as follows: The housing *C* was removed and the loose pulley taken off and bored out sufficiently to receive the split bushing *D* which is shown enlarged at the right-hand side of the illustration. The bore of this bushing was machined out to the proper size to make it a good running fit on the worn part of the shaft and a sliding fit in the loose pulley. The bushing was then split on one side, as shown in the illustration,



Method of bushing a Worn Loose Pulley

and numerous holes were drilled to receive the lubricating grease. The bushing was then sprung over the large part of the shaft and pushed along to its position *B*, the split construction allowing the bushing to come together to fit snugly on the smaller diameter. A brass liner was placed in the slot, after which the pulley was slipped over the bushing. When the belt was put on and the machine once more placed in operation, it was found that a very satisfactory repair had been accomplished.

Hamilton, Ontario, Canada. JAMES H. RODGERS

SUB-PRESS PIERCING DIE

One day when I had finished a job on which I had been working for several hours, I went to the foreman and asked him for a new assignment. He handed me a piece of steel window sash and told me to make a set of dies for piercing it. The problem was a difficult one and I studied it for a long time before finally developing the sub-press die which forms the subject of the present article. In a shop where the tool designing is handled by a special department, it is possible that they might have accomplished the same result with less expenditure in time and effort, but the tool that I finally produced gave very satisfactory results. The piercing of these holes was formerly done by hand and required from one to two hours for each hole.

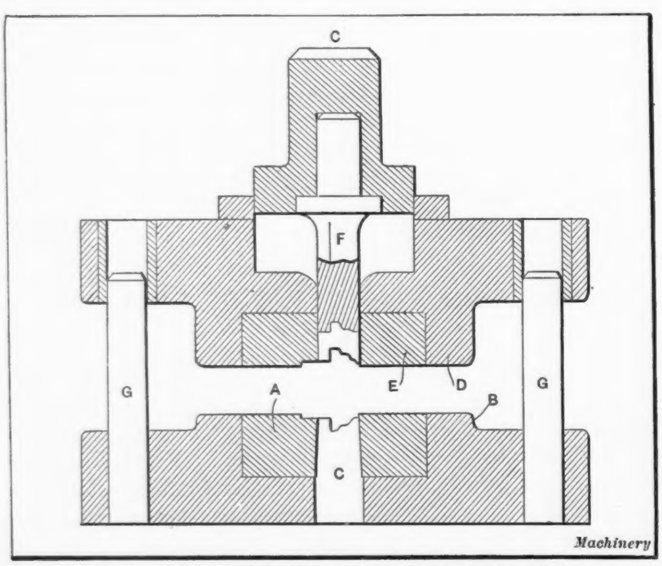


Fig. 1. Sub-press Die for piercing Metal Window Sash

This die is used in a double-acting press and a general idea of its construction will be obtained by referring to the cross-sectional view. The lower die *A* is made of tool steel and grooved across its top face to receive one-half of the section of the window sash to be pierced. This die is supported by the cast-iron bolster *B* and a hole *C* is cut through the die and bolster so that the piercings can drop out into a receptacle placed under the press to receive them. A cross-sectional view of the window sash is shown at *J* in Fig. 2 and the shape of the hole to be pierced is illustrated at *K*. The upper die-holder *D* is also made of cast iron and supports a tool steel die *E* which is machined similar to the lower die. This die also has a hole machined through it of the same shape as the hole in the lower die. This hole does not have any clearance, however, as it is provided for the piercing punch *F*. The cast-iron block *D* is fastened to the outer slide of the press, and the stroke of this slide can be adjusted by means of screws so that it comes down to a point where the faces of the dies *A* and *E* are almost in contact. In this position, the work is securely held in the transverse groove which runs across the faces of the die members. This will be readily understood by comparing the form of the dies with the cross-sectional view of the window sash shown at *J* in Fig. 2. The punch *E* is of tool steel and, as formerly mentioned, it pierces a hole of the form shown at *K* in Fig. 2. The punch is carried by the inner slide and is a snug working fit in the upper die. After the work is gripped between the dies, the inner slide descends and the punch *F* pierces the hole.

Four hardened and ground pins *G* are pressed into the bolster *B* and these pins slide in hardened bushings in the upper die-holder. These pins are provided for the usual purpose of maintaining absolute alignment between the upper

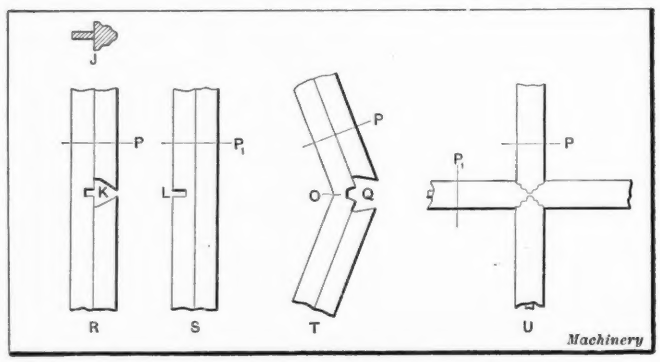


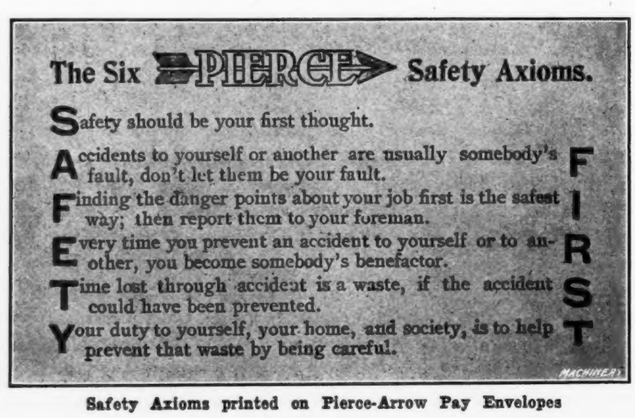
Fig. 2. Work done by Die shown in Fig. 1

and lower die members. Another form of steel window sash is shown at *S* in Fig. 2, a simple punch being used to cut out the slot shown at *L*. At *T*, the piece of sash shown straight at *R* is illustrated after it has been bent open so that the hole *K*—pierced by the die illustrated in Fig. 1—is enlarged to the form shown at *Q*. The piece of sash *S* is then slipped into this opening *Q* and moved along so that the slot *L* can drop over the flange at *O*. The piece *T* is then bent back around the piece *S* so that a firm joint is produced. The finished joint is shown at *U* in Fig. 2.

Toronto, Canada. SPRING CRAIG

PIERCE-ARROW SAFETY AXIOMS

The Pierce-Arrow Motor Car Co., Buffalo, N. Y., has recently inaugurated a strenuous campaign with the view of eliminating the possibility of the occurrence of avoidable accidents in its plant. Realizing that success in such a movement is dependent upon cooperation between the employer and the employe, several methods of securing the workmen's interest in this movement have been adopted. A large bulletin board is used, upon which photographs, articles and notices



The Six PIERCE Safety Axioms.

Safety should be your first thought.

Accidents to yourself or another are usually somebody's fault, don't let them be your fault.

Finding the danger points about your job first is the safest way; then report them to your foreman.

Every time you prevent an accident to yourself or to another, you become somebody's benefactor.

Time lost through accident is a waste, if the accident could have been prevented.

Your duty to yourself, your home, and society, is to help prevent that waste by being careful.

F I R S T

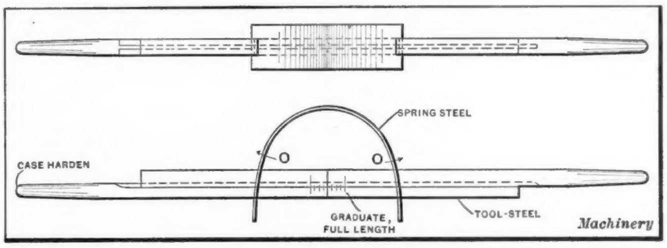
Safety Axioms printed on Pierce-Arrow Pay Envelopes

are posted, relative to ways and means for the prevention of accidents. Another useful idea consists of having what are known as the "Six Pierce-Arrow Safety Axioms" printed on the pay envelopes in which the men receive their wages. This calls the question of safety to the attention of the men in a very forcible way and it appears that the idea is one which other companies would do well to adopt.

Buffalo, N. Y. GEORGE B. MORRIS

ADJUSTABLE PIN GAGE

As the old-fashioned pin gage is still used by many machinists, I present a design of an adjustable gage which I worked up from a tool in the possession of a shop-mate. Although the gage in question was made more than fifty years ago, it would still be considered a useful tool for transferring sizes where a wide variation exists. The ability of this pin gage to stay set is surprising, and the quickness with which it can be adjusted for the requirements of a wide range of work—without necessitating the insertion of extra rods—is another strong point in its favor. The contact points at each end of the gage should be hardened and



An Adjustable Pin Gage

I would suggest graduations on the side reading to at least 1/16 inch. The arrows *O* represent the direction in which the tension of the spring acts.

Denver, Colo. STANLEY EDWARDS

DRILLING EQUI-DISTANT HOLES IN A STRAIGHT LINE

In MACHINERY for July, G. L. C. describes an excellent way of drilling a number of holes in a straight line, one inch between centers. There is another method which will, I think, give fully as accurate results in a somewhat shorter time. Two one-inch disks, such as we use for setting micrometers, are provided with bushings to suit the drill to be used. Fig. 1 shows the method, so a description is hardly necessary. The disks are clamped to the work, in contact with each other and with a straightedge located at the proper distance from the desired line of holes. When two holes have been drilled No. 1 disk is shifted to the place indicated by the dotted lines and No. 3 hole is drilled, and so on.

Of course, the same plan can be used for holes the centers of which are not one inch apart, by utilizing standard disks, if one has a pair of the required diameter, or, if these are lacking, by turning up a pair for the purpose.

A recent job required two rows of holes, as shown in Fig. 2, the holes being ⅞ inch between centers, the lines of holes also being ⅞ inch apart, and the holes "staggered." Two ⅞-inch disks, with their bushings, located the lower line of holes. To determine the diameter of the disk *D*, it

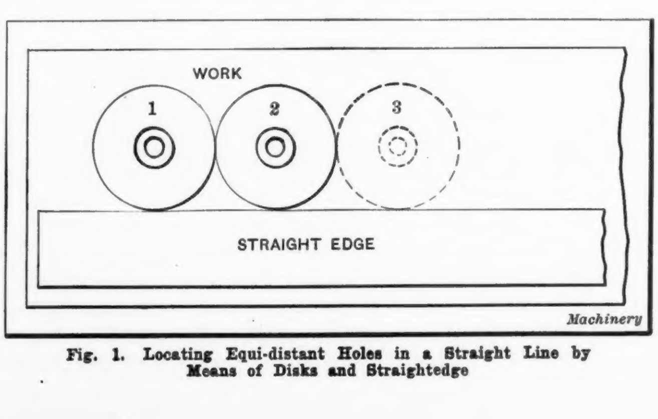


Fig. 1. Locating Equi-distant Holes in a Straight Line by Means of Disks and Straightedge

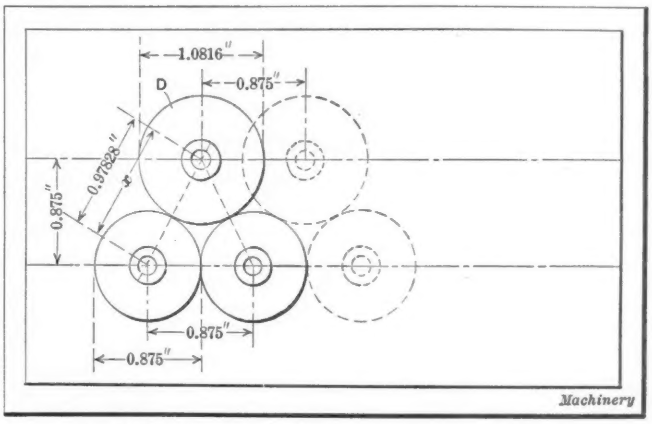


Fig. 2 Locating Parallel Rows of "Staggered" Holes by Means of Disks

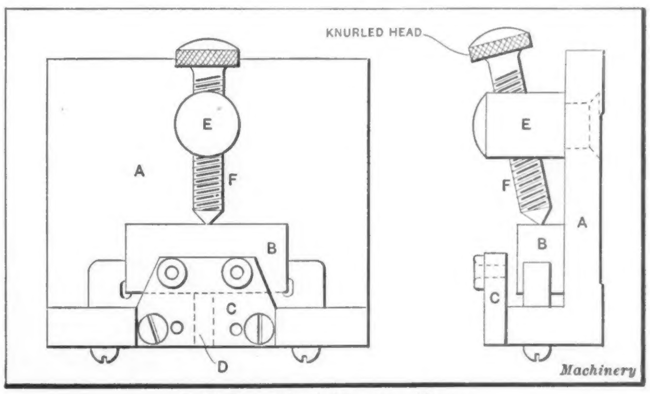
was necessary to find the distance *x*, which proved to be 0.97828 inch. Subtracting from this 0.4375 inch (the radius of the ⅞-inch disk) leaves 0.54078 inch as the radius of *D*, which was accordingly made 1.0816 inch diameter.

Anyone who has much of this kind of work to do, whether in a jobbing shop or in toolmaking, will find that with a few drill bushings and disks (the latter made from machine steel, when hardened disks are not available) many jobs can be done quickly and accurately that without these simple aids would entail a considerable expenditure of time and trouble.

New London, N. H. GUY H. GARDNER

DRILL JIG FOR RAPID PRODUCTION

A drill jig having several points of merit is shown in the accompanying illustration, which is presented in the hope that the same idea may be found of value in the design of tools for use in the production of similar classes of work. The base is a simple casting *A* which is provided with feet or pads and with a rib running along one edge. In order to explain the operation of this tool, assume that the work to be drilled is shown at *B*, the piece having two holes to be drilled in it. For locating these holes a bushing plate *C* is fastened to the top of the rib on the base casting, and is



Drill Jig with Quick-acting Clamp

fitted with bushings of the required size. A hole *D* is drilled through the rib to provide for the use of a knock-out pin, should it be required.

This completes the jig with the exception of the locking mechanism which is its chief feature. The shoulder post *E* is riveted to the base so that it can just be turned with the thumb and finger. Then a knurled headed screw *F* with a conical point is mounted in the post *E*, as shown in the illustration. The screw *F* is used for clamping the work in the jig and provides sufficient leverage so that the post *E* can be easily turned. When the drilling has been finished on a piece, less than half a turn releases the screw *F*, after which the screw is turned through 90 degrees so that the work may be lifted out of the jig and a fresh piece substituted in its place. It is evident that this arrangement is the means of saving a great amount of time which would otherwise be occupied in screwing up the clamp-screw to

engage the work and then loosening it sufficiently to enable the finished piece to be removed from the jig.

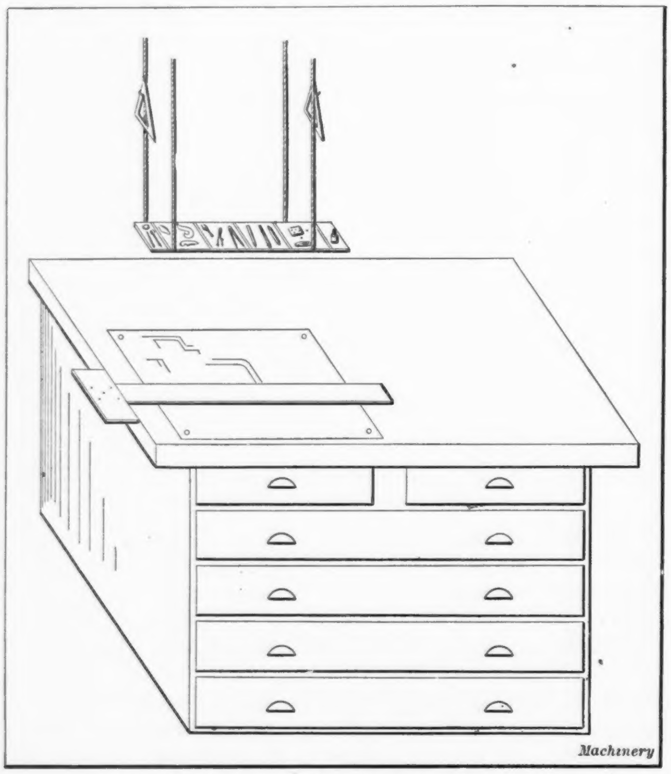
Middletown, N. Y. DONALD A. HAMPSON

HANGING SHELF FOR DRAWING INSTRUMENTS

Every draftsman knows how difficult it is to keep drawing instruments convenient and safe under ordinary conditions. If they are put on the drawing table they are sure to be temporarily lost by being covered with drawings or other papers; or worse, they will be pushed off the table and be more or less damaged. Many draftsmen try to overcome this difficulty by keeping the instruments in a drawer, but as this interferes with movement around the desk and necessitates keeping some tools on the board, it does not obviate the trouble.

However, the arrangement which is here described avoids these objections and while not at all complicated gives the draftsman greater freedom in moving about the table and arranging the various implements and accessories which he must use from time to time. This arrangement consists of a plate glass shelf hanging over the drawing table. The shelf should be held up by chains secured to the ceiling and should be fastened to them in a way that will prevent the chains from creeping along the shelf. This can be accomplished by stretching a rubber band across the glass and tying it to the chains. This arrangement will usually give the necessary friction to keep the shelf in place on the chains. The height of the shelf should be about six inches above the draftsman's eyes when working over the board; this will prevent him hitting his head against it and also enable him to look up and see where his tools, books, etc., are located on the shelf. This height is also convenient for him to reach, especially when he wants one of the drawing instruments.

By using chains for supporting the shelf, the draftsman can readily insert hooks in the links to hold his triangles, T-square and other special and somewhat unwieldy tools. To provide means for separating the various kinds of drawing instruments, all that is necessary is to place rubber bands



Convenient Hanging Shelf for Drawing Instruments

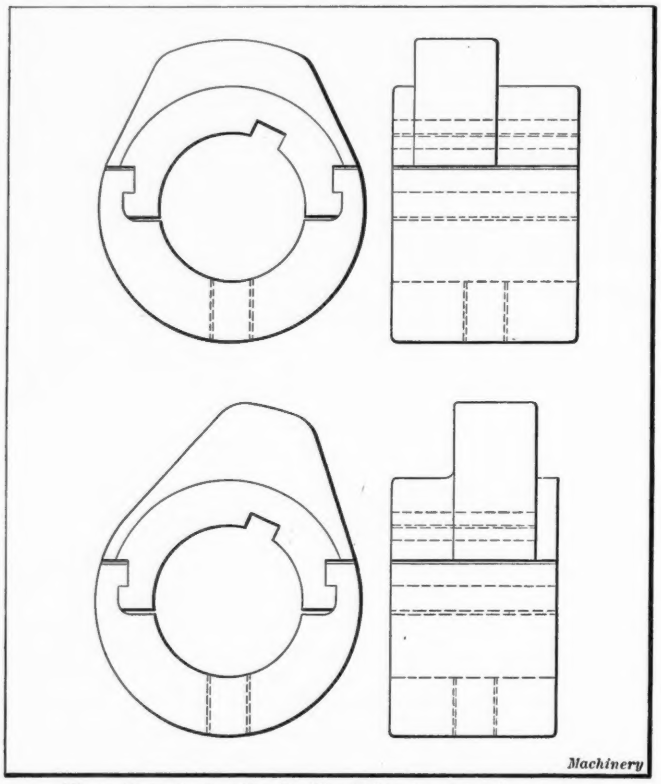
around the shelf, as only a small ridge is required for the purpose. Ink can be placed on the shelf when not in use; at other times it is essential to have it on the drawing board, and, of course, it should be in a substantial holder to prevent it being knocked over. The only other feature that it is often necessary to look out for is the electric light which the draftsman may have over his desk, and this in many cases can be tied to the shelf itself.

A shelf of this kind is remarkably convenient after it has been in use for a little while, because it then becomes an easy matter to raise one's hand to the shelf for whatever is desired. The transparency of the glass makes the actual location of all accessories apparent, and it is safe to say that the draftsman, after once becoming used to such a shelf, will wonder how he ever got along without it. The saving it makes in lessening the knocking of instruments and pencils off the drawing board more than pays for any cost it may entail.

Washington, D. C. A. P. CONNOR

SLIP-ON ASSEMBLING CAMS

The accompanying illustration shows special assembling cams used for locating the exhaust and intake cams on heavy gas engines. It will be seen that these cams are made in two parts which are dovetailed together, the purpose being



Slip-on Cams for locating Regular Exhaust and Intake Cams on Heavy Gas Engines

to make them so they will be convenient for use in the assembling department. The cams are exact duplicates of the regular type used on these engines except for the fact that they are made in two parts. They are fastened in place on the shaft of the assembled engines and enable accurate measurements to be made for the locations of the regular cams, thus doing away with any guesswork. After the locations have been determined, the keyways are cut in the crankshaft and the regular cams assembled in place. These special cams also afford a convenient method of trying out cam rollers, push rods, etc., before the regular cams are assembled on the shaft. It will be evident that the dovetailed arrangement enables the cams to be readily put on and taken off the shaft, as often as necessary, without requiring the shaft to be removed from the case. M. W. W.

SETTING TOOL WHEN CUTTING MULTIPLE THREADS

The accompanying table gives the distance to move the lathe carriage back when cutting multiple threads in order to locate the tool for cutting the other thread groove or grooves, as the case may be. For example, when cutting a double thread having $1\frac{1}{8}$ thread per inch (that is, $1\frac{1}{8}$ turn per inch of one of the double threads), first complete one of the thread

grooves, then stop the lathe, disengage the lock-nuts and move the carriage back four inches (as shown by the table); then close the lock-nuts at this point, and if the tool is not back far enough to begin the cut, reverse the lathe and run the carriage back to the desired position.

The distance to move the carriage back may be determined by the following rule: Multiply the number of threads per inch by a number that will give a whole number as the result. Divide the product by the figures 2, 3 or 4 (depending upon whether the thread is double, triple or quadruple), and multiply the quotient by the lead of the thread; the result will be the distance to move the carriage back for locating it for the next cut. If the final result is not a whole number, the number of threads per inch in the lead-screw must be divisible by the denominator of the fraction in the final result.

To illustrate the application of the rule, suppose a triple thread is to be cut having 2½ threads per inch. $2\frac{1}{2} \times 2 = 5$, and $5 \div 3$ (this being a triple thread) $= 1.66$. The lead of the thread $= 1 \div 2\frac{1}{2} = 0.40$. Multiplying 1.66 by $0.40 = 0.664$, or 2/3 inch; hence, if the tool is moved back 2/3 inch it will be located for taking the next cut, although it may be necessary to reverse the lathe in order to bring the tool back to the starting point at the end of the work.

It was not the intention of the writer to refer to the cutting of worms of coarse pitch, but there is one example of this work which may be of interest to the younger men, although well known to older machinists. A worm having a lead of 3 inches had to be cut on a cast-iron blank 6 inches long. This required two turns of the blank while the lathe carriage or

DISTANCE TO MOVE LATHE CARRIAGE FOR SETTING TOOL WHEN CUTTING MULTIPLE THREADS

Threads to be Cut, per Inch	Threads per Inch required on Lead-screw	Distance to Move Carriage, Inches
Double Threads		
1	Even	1/2
1 1/8	Any	4
1 1/4	Any	2
1 3/8	Any	4
1 1/2	Any	1
1 5/8	Any	4
1 3/4	Any	2
1 7/8	Any	4
2	4, 8, 12	1/4
2 1/8	Any	4
2 1/4	Any	2
2 3/8	Any	4
2 1/2	Any	1
2 5/8	Any	4
2 3/4	Any	2
2 7/8	Any	4
3	Even	1/2
3 1/8	Any	4
3 1/4	Any	2
3 3/8	Any	4
3 1/2	Any	1
3 5/8	Any	4
3 3/4	Any	2
3 7/8	Any	4
4	8, 16	1/8
4 1/8	Any	4
4 1/4	Any	2
4 3/8	Any	4
4 1/2	Any	1
4 5/8	Any	4
4 3/4	Any	2
4 7/8	Any	4
5	Even	1/2
5 1/4	Any	2
5 1/2	Any	1
5 3/4	Any	2
6	4, 8, 12, 16	1/4
Triple Threads		
1	3, 6, 12	1/3
1 1/4	3, 6, 12	1 1/3
1 3/4	3, 6, 12	1 1/3
2	6, 12	1/6
2 1/2	3, 6, 12	2/3
2 3/4	3, 6, 12	1 1/3
3	9	1/9
3 1/4	3, 6, 12	1 1/3
3 1/2	3, 6, 12	2/3
4	3, 6, 12	1/3
Quadruple Threads		
1	4	1/4
1 1/4	Any	1
1 1/2	Even	1/2
1 3/4	Any	1
2	8, 16	1/8
2 1/4	Any	1
2 1/2	Even	1/2
2 3/4	Any	1
3	4, 8	1/4
3 1/4	Any	1
3 1/2	Even	1/2
3 3/4	Any	1
4	16	1/16

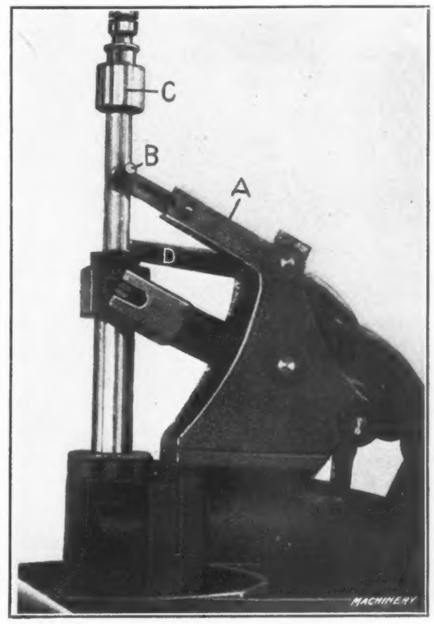
Machinery

tool traveled 6 inches. The tool was fed in the usual way for the first cut, and after closing the lock-nuts the tool was placed within 1 inch of the end of the blank, after which the lathe was stopped. A chalk mark was then put on the end of the blank at the height of the tool. When taking the following cuts, it was not necessary to stop the lathe at the end of each cut. The lock-nuts were disengaged, the carriage run back to within 1 inch of the end of the blank, and when the chalk mark came around to the top of the tool, the nuts were closed. When using this method, the lock-nuts must be closed promptly when the time arrives, for if they are not engaged with the proper threads on the lead-screw, something will happen before the tool can be moved out.

La Salle, N. Y. C. H. LAKE

IMPROVED TAPPING MACHINE

The accompanying illustration shows the top of a Garvin automatic tapping machine equipped with an auxiliary tripping lever *A*. I designed this lever to adapt the machine for handling certain classes of work, and found that it greatly increased the rate of production. The auxiliary lever is made to clamp onto the hub of the regular tripping lever on the machine, and may be moved out of the operating position when so desired. The lever carries a roller on the outer end of the slide, the slide being telescoped back into the body *A* when it is desired to throw the auxiliary lever out of action. A handle *B* is provided for adjusting the position of the slide.



Auxiliary Tripping Lever applied to Garvin Tapping Machine

Those who are familiar with this type of tapping machine know that the adjustable stop *C* can be set to come in contact with the tripping lever *D* to reverse the direction of rotation of the tap at the desired point. The reversal is secured by means of a clutch located between pulleys which drive in opposite directions. In performing tapping operations on work which has surfaces at different heights from the work-table or where holes are to be tapped to different depths, it is obviously necessary to reset the position of the stop *C*. To avoid this difficulty, the auxiliary lever *A* was provided. This lever can be set to reverse the machine in tapping holes to a given depth, and after such holes have been finished, the auxiliary lever can be pushed back out of the way to enable the stop *C* to engage with the regular reversing lever *D* for tapping the remainder of the holes.

Buffalo, N. Y. W. W. LAWYER

ALLOWANCES IN PIPE BENDING

I have just been reading the article by William F. Fischer, "Steam Power Plant Piping Details," in the July number of MACHINERY, and am much interested in his methods of calculating the length of straight pipe required for bends. It is, of course, a matter of trigonometry as far as theory goes, but there is a practical point which has escaped him. I spent a number of years in the engineering department of a large corporation which used a great many pipe bends, and their practice was to reduce the theoretical length of the curved portion about five per cent. In other words, their experience showed that the work of bending the pipe caused a slight elongation on the center line; the neutral axis, instead of being on the center line, appeared to be about half way between the center line and the inner side of the bend. This made the length of a 90-degree bend $1.5 \times R$ instead of $1.57 \times R$, and of a 180-degree bend $3 \times R$, which greatly simplifies the figuring.

Their standard radius of bend was six times the nominal diameter of the pipe, so that the above rule would apply, possibly, only to bends of that radius. As they never varied the radius for a given size of pipe, owing to the cost of the dies, I am not prepared to say what the effect would be with bends of shorter or longer radius. While the inaccuracy due to

using the theoretical method given by Mr. Fischer might be negligible in the case of small pipes, and could probably be adjusted in the majority of cases, it would evidently be serious in the case, say, of a 90-degree bend of 10-inch pipe, having a radius according to the above standard of 60 inches, which would give a discrepancy between the theoretical and practical methods of $60 \times 0.07 = 4.2$ inches.

The standard practice described was found to give excellent results with full-weight pipe up to 12 inches in diameter, and a few bends were made during my experience of 16 inches outside diameter pipe with the same results. This company had many miles of lines of 12-, 10-, and 8-inch pipe, and used 180-degree bends or 90-degree bend offsets to take care of expansion, placing them 200 to 250 feet apart.

Cleveland, Ohio R. A. WRIGHT

In reading over the above criticism to my article, "Steam Power Plant Piping Details," which appeared in the July number of MACHINERY, I was somewhat surprised at Mr. Wright's method of calculating the length of straight pipe necessary for 90- and 180-degree pipe bends. Before proceeding further I wish to say that the method of calculation which I employ and which I recommend in my article has been used by several of the largest pipe bending concerns in this country, and, as far as I know, is still in general use. Several years ago, while employed as chief draftsman by a large manufacturing concern in the East, making a specialty of large steel and wrought iron pipe bends, I was called upon to compute the dimensions of all types of pipe bends, and also to check the dimensions of the bends figured by my assistants before the sketch sheets were sent to the bending shop. I made these computations regularly for a period of between four and one-half and five years and always employed the method of calculation which I describe and recommend in my article, making no allowance for any slight elongation of the pipe which in some cases is apt to occur during the bending process. Without going into actual figures I might safely say with some degree of certainty that I have figured at least nine hundred or one thousand pipe bends ranging in size from the smallest pipe size up to 22 inches in diameter. These bends were made up in the shop from our bending sheets and carefully checked afterwards for possible errors before shipment. The only time, to my knowledge, that any of these bends failed to measure up correctly to dimensions was when one of my assistants or myself made an error in our calculations, that is, an error in calculating the proper length of pipe to be cut and flanged ready for the bender. Furthermore I believe if Mr. Wright will go to the trouble of writing to several pipe manufacturers who make a specialty of bending large pipe that he will learn that they, too, calculate the length of straight pipe as I did.

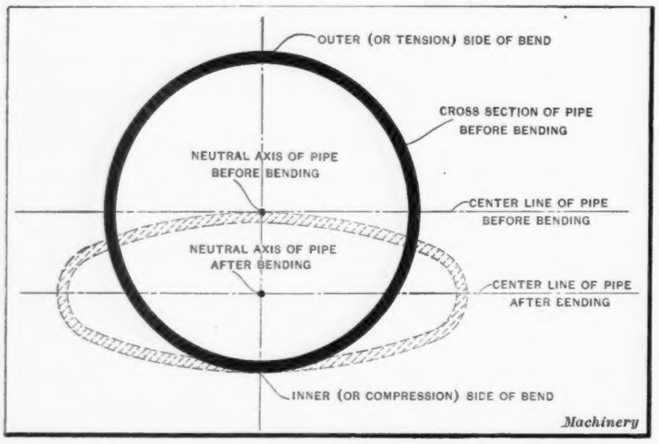


Illustration showing Approximate Shape assumed by Pipe if Neutral Axis should change its Location during bending as indicated

Knowing that my method of calculating pipe bends has proved correct in practice as well as in theory, I do not hesitate to recommend what I know to be a correct method of calculation. The fact that the corporation mentioned in Mr. Wright's letter found it necessary to make a five per cent allowance for elongation, together with the statement that "the neutral axis of the finished bend, instead of being on the center line of the pipe, appeared to be half way between the center line and the inner side of the bend" does not convince me that I am in error, but rather that the bends referred to in Mr. Wright's letter, whether of large or small diameter, were greatly distorted during the bending process, and were not curved to a true radius. This would account for the discrepancies in the dimensions of the finished bends. In nearly all cases where large pipes are bent over forms or dies without first being filled with sand and well rammed to pack the sand tight, the pipe will assume a flattened or oval shape in cross-section during the bending process. Judging from Mr. Wright's statements this is exactly what happened to the bends mentioned in his letter, as I will show below.

Returning again to Mr. Wright's statement, "The neutral axis of the pipe, instead of being on the center line of the pipe, appeared to be half way between the center line and the inner side of the bend," tends to prove that the bends, when finished, must have appeared in cross-section, about as shown by the dotted lines in the accompanying illustration. Evidently Mr. Wright is in error regarding this particular point, as the illustration shows what would occur if his statements were correct. The pipe, as shown, would be flattened to about one-half its original diameter in bending. Furthermore, before assuming this shape in cross-section the pipe would buckle so badly on the compression side of the bend as to make the bend worthless when finished. (See also Fig. 68 and description of same in the July number of MACHINERY.) Filling with sand and ramming well before bending tends to prevent the pipe from flattening, provided, of course, that the bend is not curved to too small a radius. If the bend is curved to a true radius and does not flatten to any great extent in bending, it will not elongate to any great extent on the center line or neutral axis of the pipe, but will act similarly to a loaded beam which deflects under the load, with the upper fibers in compression and the lower in tension. In other words, the upper fibers of the material, on the tension side of the bend, are stretched, and the lower fibers, on the compression side of the bend, are shortened, but the neutral axis remains the same, or very nearly the same length before and after the pipe is bent to shape. Any slight elongation of a pipe bend can readily be taken care of by the bender when truing up the finished bends to dimensions.

Attention may also be called to the Crane Co.'s pocket catalogue No. 40, May, 1912, page 499, giving dimensions of standard pipe bends. Take, for example, the 14-inch U, or 180-degree bend, No. 4. Radius R is 70 inches. Length of straight (X), each end of bend, 16 inches. The lineal feet of pipe in a bend of these dimensions is given as 21 feet. Referring to the July number of MACHINERY, Fig. 70, we find that the length of straight pipe required to make a 180-degree bend of the above dimensions would be as follows:

Length of straight pipe $= 2 \times F + 3.14R = 2 \times 16 + 3.14 \times 70 = 32 + 219.8 = 251.8$ inches, or 20 feet 11.8 inches, as against 21 feet given in the catalogue.

To conclude, I would therefore say that as far as I know it is not customary to make allowance for elongation of the pipe during the bending process, but as different designers and manufacturers vary considerably in their customs, I am not prepared to say that all manufacturers compute their bends in the same manner as I describe and illustrate. I can say, however, that during my fourteen to fifteen years experience with power plant pipe work I have never heard of one case in which the piping manufacturer made any such allowance for elongation as mentioned in Mr. Wright's letter.

New York City. WILLIAM F. FISCHER

* * *

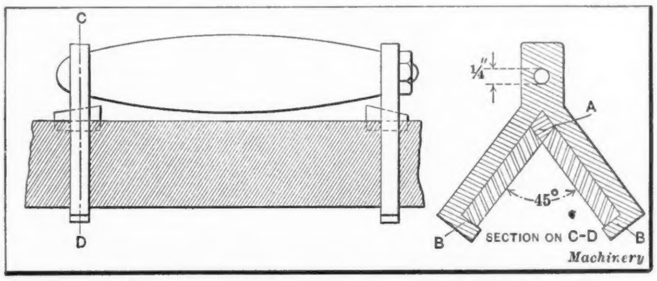
The Calumet and Hecla Mining Co. has developed a new process for treating the waste sands of its dumps. For fifty years, the sands have been dumped into Torch Lake and over 30,000,000 tons containing an average of sixteen pounds to the ton of copper have accumulated. The new regrinding and leaching process applied to these sands will extract over ten pounds of copper to the ton, reducing the copper losses to a little over two pounds to the ton.

SHOP AND DRAFTING-ROOM KINKS

INGENIOUS MEANS AND SHORT CUTS FOR SAVING LABOR AND MATERIALS

A FILING KINK

There are few machinists who have not been cut by the rough edges of pieces of tin or other sheet metal used to form dash plates of machines and for similar purposes. When such pieces are cut with a shear, there are numerous rough burrs which are capable of giving one a nasty cut. The ordinary method of removing such burrs is a tedious operation, and there are probably few jobs that are more likely to be slighted when put in the hands of the average workman. To eliminate the tedious character of this work and also to increase the workman's efficiency, the following will be found a very useful "kink."



Convenient Method of filing down Sharp Edges

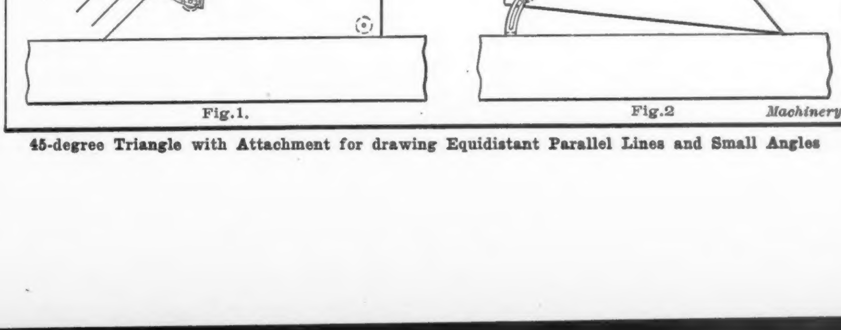
Referring to the illustration it will be seen that two files are clamped together by means of two inexpensive forgings. These forgings are drilled to receive a bolt which holds them in position at each end of a wooden handle. The files are held in place by means of the wedges *A* and the shoulders *B* at the bottom of the forgings. The feet *B* are made slightly wider than the thickness of the files, as this makes the binding action of the bolt more effective. Using this tool, both sides of a piece of sheet metal are filed simultaneously and a few strokes—changing the angle of the tool at each stroke—produce a very smooth round edge. Since the greater part of the files is brought into use when thus applied, the method is also the means of effecting a saving in the number of files used.

Stillwater, Minn. R. C. MacLachlan

ATTACHMENT FOR 45-DEGREE TRIANGLE

The accompanying illustration shows an inexpensive, yet useful, attachment for any forty-five degree triangle, to facilitate the drawing of equidistant parallel lines for representing a section or the drawing of numerous small angles. The attachment consists of a slotted curved arm, with one end pointed and bent down, and the other end flat and bent in the opposite direction. This arm is held to the triangle by a screw with a large thin flat head and a knurled nut.

By setting the arm at a given distance a series of equidistant parallel lines may be drawn by moving the triangle along the edge of the T-square or ruler until the pointed end is over the last line drawn, thereby bringing the edge of the triangle into position to draw another line. (See Fig. 1.)



45-degree Triangle with Attachment for drawing Equidistant Parallel Lines and Small Angles

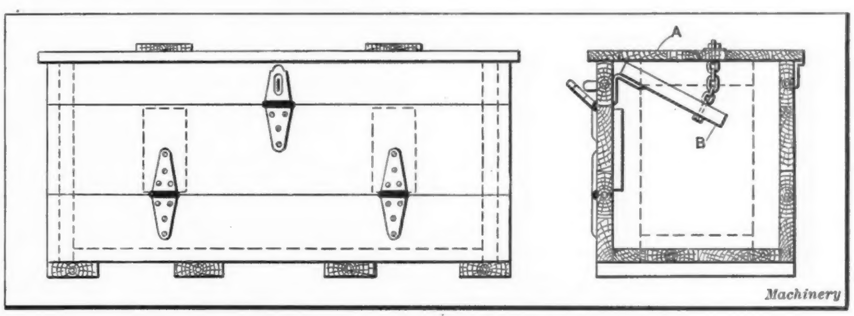
By changing the attachment from the position in Fig. 1 to another hole in the triangle located as shown in Fig. 2, and reversing the arm so that the flat end is down and against the guiding edge, either side of the triangle can be set at any desired small angle.

Hartford, Conn. Henry E. Gerrish

SCRAP BRASS BOX

The accompanying illustration shows the design of a box used for scrap brass or other valuable material. In the shop where the writer is employed, considerable trouble was experienced in keeping such material in ordinary boxes secured with padlocks. It was necessary for several people around the shop to have a key to the box and this made it very difficult to fix the responsibility when material was stolen. After several attempts had been made to overcome this difficulty, we designed the box which forms the subject of this article. It will be evident from the illustration that the material kept in it is absolutely safe and still the box can be opened to allow anyone in the shop to place material in it without requiring the use of a key.

It will be seen that the box has two doors. The door at the side is kept locked at all times, except when it is required to remove material from the box. The door at the top is used for dumping scrap into the box. The top door is double, and when the upper door *A* is lifted, a chain connected to it pulls up an auxiliary door *B* which is hinged to the inside of the box. The arrangement is such that the top door can be raised only about eight inches before the lower door has reached the highest point of its travel. When the upper door has been raised eight inches, the lower one is in a horizontal position and closes the box. The material which is to be put into the box is dropped in onto the top of the lower door, and when both doors are dropped, the lower one is inclined at an angle of about 45 degrees, allowing the material to roll off it into the box. It will be evident that it is impossible for material to be taken out except through the side door, and as only one man has a key to this door he is held strictly responsible for the contents of the box which are entrusted to his care.



Scrap Brass Box which prevents Material from being stolen

Poughkeepsie, N. Y. R. F. Calvert

* * *

The Geological Survey reports that the value of metal recovered from waste and scrap during 1913 was $73,000,000.

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

INSPECTING LARGE WORM-WHEELS

T. E. M.—I would be interested in seeing an article dealing with the best method of inspecting or checking large worm-wheels. It is our practice to cut wormwheels on a machine which feeds the hob radially into the gear. Some of the hobs have inserted teeth which do not cut the throat and consequently in some sizes the throat is uncut with relation to the teeth and the ordinary method of measurement by calipers is not feasible. It is possible to provide a vernier measuring the distance between two cones having profile dimensions equivalent to a meshing rack tooth, but this method is expensive and because of the weight of the vernier, which would have to be about three feet long, it is not very accurate. Probably this problem has been solved by others and information may be available on the subject although it has never been published.

This inquiry is referred to our readers for discussion.

CUTTING ASBESTOS BOARD

C. F. J.—Can you tell me how to cut asbestos board one-half inch thick economically? We have been using a saw, but the saw dulls very quickly.

A.—The H. W. Johns-Manville Co., New York City, advises the use of an ordinary wood-working saw table with circular saw sixteen inches diameter, ten gage, five teeth to the inch. It is true that the asbestos board dulls the saw quickly, but the company overcomes this difficulty by using automatic saw setting and filing devices, the plant being equipped with these devices to put the saws in good order quickly. The saving of time effected by the use of the circular saw much more than compensates for the loss of time and labor caused by frequent sharpenings.

DIMENSIONS OF FOUNDATION BOLTS

G. C. H.—A 3-inch foundation bolt is to have an enlarged lower end to receive a steel cotter pin. It is required to compute the necessary dimensions so that the lower end of the bolt and the cotter pin will have the same strength as the smaller section of the bolt in which the thread is cut. The bolt is made of wrought iron which has a tensile strength of 50,000 pounds per square inch, a shearing strength of 45,000 pounds per square inch and a crushing strength of 50,000 pounds per square inch. The cotter pin is made of steel which has a shearing strength of 68,000 pounds per square inch and a crushing strength of 75,000 pounds per square inch.

Answered by William L. Cathcart

The bolt is to be of wrought iron and the key of forged steel. Taking the working stresses as given, we have:

S_t = tensile strength of wrought iron = 50,000 pounds per square inch;

S_c = crushing strength of wrought iron = 50,000 pounds per square inch;

S_s = shearing strength of wrought iron = 45,000 pounds per square inch;

S_c' = crushing strength of steel = 75,000 pounds per square inch;

S_s' = shearing strength of steel = 68,000 pounds per square inch.

Let:

d = diameter of bolt at root of thread = 2.629 inches;

a = area of cross-section of bolt at root of thread = 5.429 square inches;

D = diameter of enlarged section of bolt;

A = area of enlarged section of bolt;

t = thickness of key;

b = width of key at middle of keyway;

h = depth of bolt below key at middle of keyway;

W = total axial load which bolt can sustain = $S_t \times a$ = 271,450 pounds.

For maximum economy of metal, all sections of both the bolt and key which are under strain should be equally strong, *i. e.*, each such section should have the same strength as that of the bolt at the root of the thread. Failure may occur by: (1) Rupture of bolt at root of thread, as shown at *B*, Fig. 2. The total stress resisting rupture is equal to the product of the area a of the bolt and the tensile strength:

$$W = S_t \times a = S_t \times 0.7854\, d^2 = 39{,}270\, d^2 \qquad (1)$$

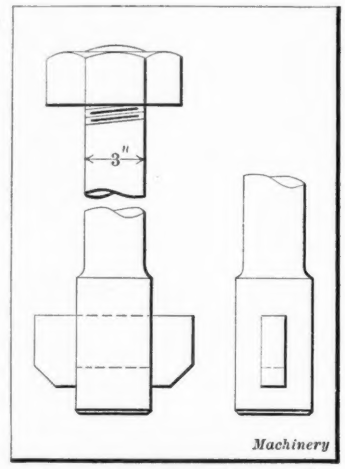


Fig. 1. Type of Foundation Bolt for which Dimensions are to be determined

(2) By rupture of the slotted section of the bolt, as shown at *C*. The resisting stress is equal to the product of the area of the cross-section of the bolt and the tensile strength:

$$W = S_t\,(A - Dt) = S_t\,(0.7854\, D^2 - Dt) = 39{,}270\, D^2 - 50{,}000\, Dt \qquad (2)$$

(3) By the crushing of the metal at the bottom of the keyway, as shown at *E*. The resistance to this crushing is equal to the area of the base of the keyway times the crushing strength:

$$W = S_c \times D \times t = 50{,}000\, Dt \qquad (3)$$

(4) By the shearing of a vertical section of the bolt below the keyway and equal in width to the key, as shown at *F*. Since both side of this section must be sheared simultaneously, the resistance to shearing is equal to the product of the shearing strength and twice the area of one side:

$$W = S_s \times 2(D \times h) = 90{,}000\, Dh \qquad (4)$$

(5) By crushing the key at the contact-surface between it and the keyway, as shown at *E*. The total resisting stress is equal to the product of the crushing strength of the metal of the key and the area of the keyway, or

$$W = S_c'\,(D \times t) = 75{,}000\, Dt \qquad (5)$$

The same action occurs at the bearing of the key on the foundation plate. The area of bearing surface at these points should be at least equal to that of the keyway.

(6) By shearing the key where it enters and leaves the bolt, as shown at *H* and H_1. Since there are two sections of the key to be sheared simultaneously, the total stress resisting shearing is equal to the product of the shearing strength

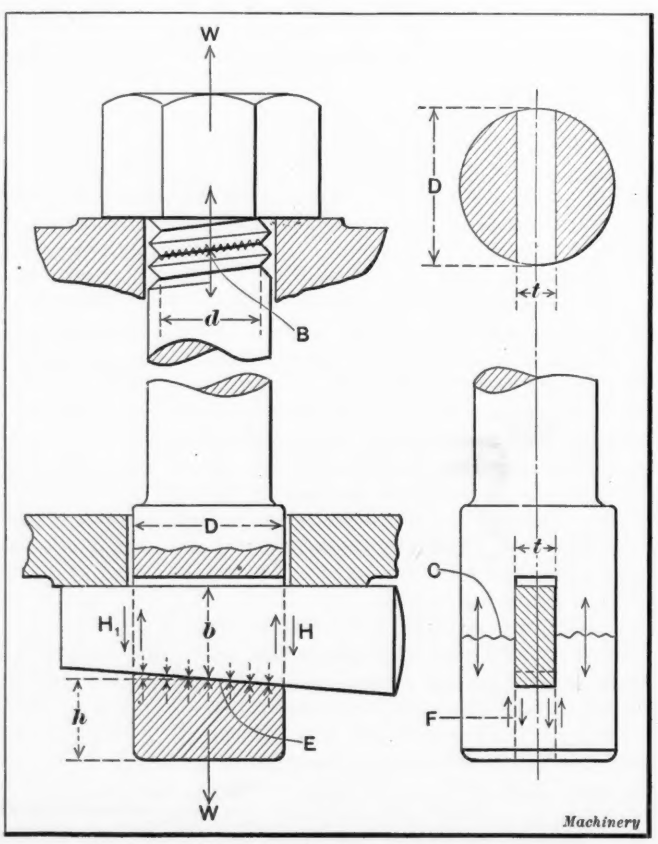


Fig. 2. Condition of Foundation Bolt when under Stress

of the metal by twice the mean cross-sectional area of the key:

$$W = S_s' \times 2\ (b \times t) = 136{,}000\ bt \qquad (6)$$

To obtain a strength at each of these various sections under strain, which shall be equal to that of the bolt at the root of the thread, it is evident that the equation giving the resisting stress in each case must be equated with Equation (1), and then the unknown values D, t, b, and h can be found by successive substitutions. Thus, to find the diameter D, equating Equations (5) and (1) we have:

$$75{,}000\ Dt = 39{,}270\ d^2$$

$$Dt = 0.524\ d^2 \qquad (7)$$

Equating Equations (2) and (1), we have:

$$39{,}270\ D^2 - 50{,}000\ Dt = 39{,}270\ d^2$$

Substituting and transposing in the preceding expression and in Equation (7) we have:

$$39{,}270\ D^2 = 65{,}470\ d^2$$

$$D^2 = 1.66\ d^2$$

$$D = 1.29\ d = 3.39 \text{ inches} = 3\ 7/16 \text{ inches} \qquad (8)$$

To find the thickness t, we proceed by equating Equations (5) and (1):

$$75{,}000\ Dt = 39{,}270\ d^2$$

Since $D = 1.29\ d$, we have by substituting and transposing:

$$96{,}750\ dt = 39{,}270\ d^2$$

$$t = 0.406\ d = 0.406 \times 2.629 = 1.067 \text{ inch} = 1\tfrac{1}{8} \text{ inch} \qquad (9)$$

To find the width b, we proceed by equating Equations (6) and (1):

$$136{,}000\ bt = 39{,}270\ d^2$$

Since $t = 0.406d$, we have by substituting and dividing by d:

$$55{,}216\ b = 39{,}270\ d$$

$$b = 0.711\ d = 0.711 \times 2.629 = 1.869 \text{ inch} = 1\tfrac{7}{8} \text{ inch} \qquad (10)$$

To find the depth h, we equate Equations (4) and (1):

$$90{,}000\ Dh = 39{,}270\ d^2$$

Since $D = 1.29d$, we have by substituting and dividing by d:

$$116{,}100\ h = 39{,}270\ d$$

$$h = 0.338\ d = 0.889 \text{ inch} = 15/16 \text{ inch.}$$

It will be observed that the values of the various dimensions deduced as above depend wholly on the working stresses assumed. Any change in these stresses will make a corresponding change in these dimensions. In any event, the latter are subject to some alteration, owing to the conditions of practice.

* * *

PRINCIPLES OF MOLDING

BY J. A. SHELLY*

The subject of molding has been fully covered in technical books and magazines by men who are recognized experts in that particular line, but these writers have usually written for the benefit of the foundryman, and their works have conveyed but little information to those not directly engaged in the trade. It is not the writer's intention to present a treatise on molding, but so many questions are asked in the shop by draftsmen and others whose work is closely related to the molder's that a brief explanation of the various methods pursued in the foundry on different classes of work may be of interest to many readers of MACHINERY.

All sands suitable for molding purposes must be open and porous to allow the steam and gases to escape freely, and must be able to hold a given form under the pressure and wash of the flowing molten metal. Such a sand must contain a sufficient quantity of clay or other binding material in order to comply with this latter condition. This binding material is either present in the sand naturally, or, if not, it must be added to it before it is fit for use; otherwise the body of sand will not hold together when dampened and compressed by ramming.

Roughly speaking, there are four branches to the molder's trade. These are, green sand and dry sand work; loam molding and core-making. Properly speaking, core-making is not part of the molder's trade as it is practiced today. It is a branch of the business that has become highly specialized of late years, and is now regarded as a trade in itself. It is, however, a very important part of the business, and one that every molder should thoroughly understand. The difference between molding and core-making is that the molder makes the mold that forms the exterior of the casting, while the core-maker makes those bodies of sand that form the interior openings or holes in the casting.

Small and medium-sized castings are generally made in molding boxes called flasks. These are made in various sizes to suit the different jobs and may be of wood or iron. The type known as snap-flasks is used for very light work. These flasks have three hinged corners and some form of snap fastener at the fourth corner to hold the box together, so that the flask may be removed after the job is molded and set in place for pouring. The men who handle snap-flask or other small work that can be done on benches are known as bench-molders, while those who take care of the heavier work that must be accomplished on the floor of the foundry are called floor-molders.

The green sand method is used to a greater extent than the others, because it is the cheapest for producing small and medium-sized castings. The term "green sand" means that molds so made are to be used at once, or while in a green or moist condition. Dry sand molding differs from the green sand method in that the molds are dried in an oven built for the purpose. It takes its name from this drying process, and for the same reason the molding should always be done in iron flasks to withstand the heat of the oven. The sand used must possess all the properties of green sand with the additional one of continuing to adhere in a compact mass during the process of drying. Molds so made will stand great pressure without distortion, and on account of their dry condition are free from steam and provide a ready escape for troublesome gases. Another advantage of this method is that the molds may be divided into a number of parts and these parts lifted away to relieve undercuts and similar places on the pattern. This is what is known in foundry parlance as "cheeking" or using "drawbacks."

Loam molding is used for large and heavy castings, or, in some cases, where the cost of a pattern would be prohibitive, because many jobs may be accomplished with a very small amount of pattern work. It is the most expensive form of molding, but it is safe and therefore is frequently the cheapest in the end. Flasks are not used in loam work. The mold is built of brick-work reinforced by iron plates and rods and clamped and bolted together where it is deemed necessary. The molding material is either natural loam or a mixture of sand and clay in the proper proportions and mixed with water to about the consistency of mortar. The loam is either worked into the mold between the pattern and the brick-work, when a pattern is used, or plastered on the bricks and worked to the desired forms by sweeps swinging from a central spindle in cylindrical work, or by strickles worked back and forth over frames when irregular forms are desired. Loam molds are made in any number of necessary sections and disjointed to relieve the pattern, thus allowing its withdrawal. When the sections are assembled in a pit with sand firmly rammed between the mold and the sides of the pit, it is ready for pouring. Loam molds are always dried, either in an oven or over an open fire, if an oven large enough to accommodate the different sections is not at hand.

Cores are either formed in boxes or by the use of frames, sweeps or strickles, and may be made in green sand, dry sand or loam. The core-maker's efforts, however, are generally confined to dry sand work, as the molder usually makes his own cores when the job is green sand or loam. When made in boxes the sand is rammed in and reinforced with iron rods to add strength and stiffness to the core. The box is really a mold to give shape to the core sand.

* * *

The new Zeppelin airship—the *Zeppelin V*—is claimed to be remarkable on account of the absence of noise from the engines. It is said to have cruised over Berlin without any noise whatever having been heard at a distance. One of the Zeppelin airships recently flew over a range of the Swiss mountains, reaching the high record for dirigibles of over 10,000 feet.

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CLEVELAND TURNING, BORING AND RECESSING ATTACHMENT

A Cleveland automatic machine fitted with a turning attachment having roughing and finishing cutters and a special boring and recessing attachment, is shown in Figs. 1 and 2, and the operation for which this tool equipment is used is illustrated in Fig. 3. By using two tools in the turning attachment, the two principal diameters can be finished concentric and to size to better advantage than with a forming tool. The important feature of the new design of recessing tool is that it will recess a long hole in two or three places or positions if desired; that is, the tool can be arranged to drop down and out of the cut as often as may be required and it will produce almost any shape of hole; moreover, one tool finishes the hole parallel.

Fig. 1 shows the turning attachment secured to the face of the turret by three of the tool shanks. The stem or bar carried in the center of the spider is fitted with two roughing and two finishing cutters. Cutter *A* rough-turns the larger diameter *J*, see Fig. 3, whereas cutter *B* reduces the bar from 3 1/2 inches to 2 3/16 inches at *K*. The two finishing cutters *C* are shown in the working position; the first one

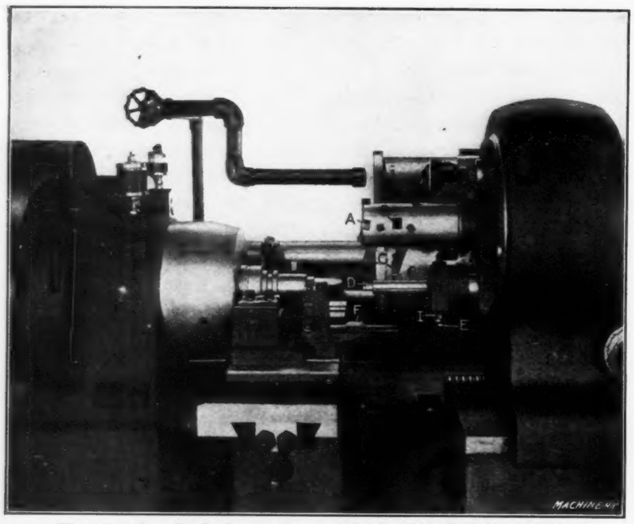


Fig. 1. Cleveland Automatic equipped with Turning, Boring and Recessing Attachment

finishes the large diameter while the second finishes the diameter previously rough-turned to 2 3/16 inches. The bar which carries the cutters is secured in the bore of the spider by means of a key and set-screw and it can easily be removed and a bar with any combination of cutters substituted. This attachment is very rigid and is intended for heavy work when it is not practicable to use a box-tool.

Fig. 1 also shows the special recessing tool in the turret. The cutter *D* of the recessing tool is supported by sleeve *G*, the cutter shank passing through a hole which is eccentric with the shank in the turret hole. Cutter *D* is fastened to the hub of a gear by means of a hollow set-screw inside of housing *H*, and it can easily be removed for grinding or replacement. Plunger *I* has a rack cut on the side which engages the gear inside of housing *H*. The ball-pointed screw *E* passes through plunger *I* and it is squared at the upper end and fitted with a lock-nut. This gives a fine adjustment to the rise of plunger *I* as it travels over cam *F* which is attached to the cross-slide. The working end of cutter *D* when at rest is parallel to the extreme throw of the eccentric hole in sleeve *G*. When turning the part illustrated in Fig. 3, the turret travels to the full stroke, bringing cutter *D* to the bottom of the hole; the cross-slide then moves forward until cam *F* is in the path of ball-pointed screw *E*, when the turret is on the return stroke. The screw *E* and plunger *I* are lifted up as indicated in Fig. 2, thus causing the pinion in housing *H* and the cutter in sleeve *G* to rotate. This sinks the tool into the side of the hole and as the turret continues to travel backward, the recessing tool is in operation as long as screw *E* is held up by cam *F*. A strong spring, which is compressed by plunger *I*, brings the cutter *D* back to rest after screw *E* passes the end of cam *F*.

A combination boring and recessing operation can be effected by sinking the cutter *D* in to the depth left for a boring cut at the bottom of the hole. A rise in the cam *F* at the proper height to suit the amount of recess required can be employed. With this arrangement, the hole can be bored and recessed in one operation. Cam *F* can also be made to any desired shape for producing an irregular form or shape. This tool may be used for an operation which usually re-

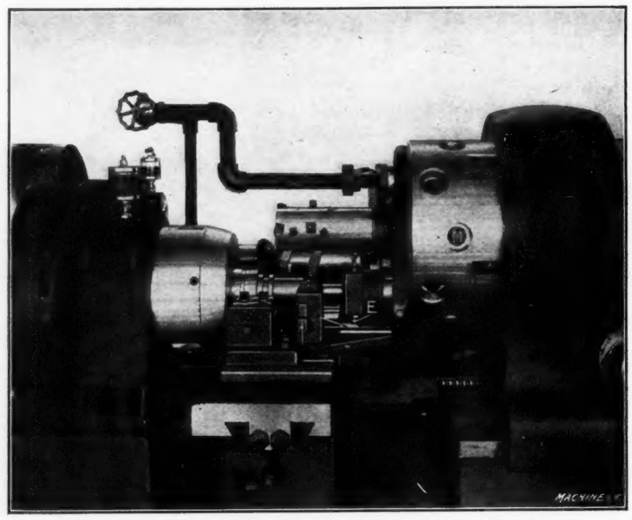


Fig. 2. Recessing Attachment in Operation on Cleveland Automatic Machine

quires two tools, that is a boring tool independent of the one used for recessing. Thus, the time for forming the recess is eliminated, which may reduce the total time one-half.

* * *

STRENGTH OF WIRE ROPE

An investigation into the strength and durability of wire ropes has been made by Prof. Eenoit of the Technical Institute at Karlsruhe. The results of this investigation are of considerable interest. The experiments were made with plow-steel wire 1 millimeter (0.03937 inch) which showed a strength of from 247,000 to 255,000 pounds per square inch, 225,000 pounds per square inch having been guaranteed. The wire was bent over a pulley of 6⅞ inches diameter, through an angle of about 90 degrees, at the rate of 1000 complete bends per hour, a complete bend being the bending of the wire from the straight and then back to the straight again. During the bending, the wire was subjected to a stress of 11,200 pounds per square inch and stood 198,710 bends. Seven wires were twisted together into a strand and bending tests

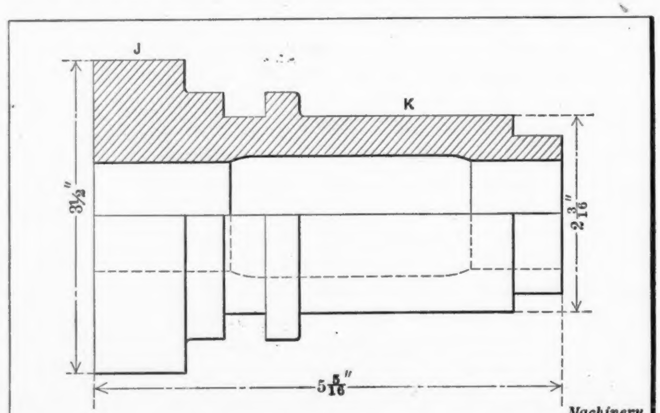


Fig. 3. Part turned, bored and recessed by Tool Equipment shown in Figs. 1 and 2

were undertaken with this strand. One or two wires were broken in the strand after from 44,800 to 47,200 bends. Three of these strands were then combined into a rope; one wire in this case broke after 22,860 bends, and the twisted strands were practically entirely broken up after 36,440 bends. The conclusions seem to indicate that twisting the strands causes considerable stress in wire rope, especially when bending over sheaves.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

BEMENT BORING, DRILLING AND MILLING MACHINE

Prior to 1850, the boring of small holes was done under the drill press, or in the lathe when great accuracy was required. For work that could not be handled on either of these machines, the usual method was to employ the portable boring-bar with a traveling head and star feed. All of these methods were more or less slow and cumbersome. In 1854 Bement brought out a horizontal borer with the spindle at a fixed height and a vertically adjustable work-table. On account of great adaptability, together with the convenience of being able to operate it from either side, this machine has continued in popularity to the present day. In 1875, the Bement Co. made another advance in boring machine design by building a new type of horizontal boring machine. This machine had a stationary post with a vertically adjustable saddle, the table being at a fixed height and provided with cross and longitudinal traverse. An adjustable outer bearing was furnished for support of the boring-bar. Since that time a large number of machines of this type and similar design have been placed on the market.

Realizing the importance of duplex control on machines of this class, the Niles-Bement-Pond Co., 111 Broadway, New York City, is now manufacturing the improved horizontal boring, drilling and milling machine illustrated herewith. This machine is of the elevating spindle type, but is symmetrical throughout with respect to the spindle axis, permitting the operator to stand on either side and have all the controlling levers within convenient reach. It is adapted for work requiring great accuracy and at the same time is designed for heavy boring. Service and durability are prominent features, the entire design being free from delicate parts. Perhaps the most striking feature is the location of the spindle saddle within the post. This makes possible the symmetrical construction about the spindle axis which has been carried throughout the design of the spindle post, bed, tables and control—an arrangement very essential on a large part of boring work. This design also affords most rigid support for the spindle. The thrust is taken on two V-tracks, one on each side of the spindle, entirely eliminating the distorting strains which are inevitable in machines where the spindles and saddles are on the front side of the post.

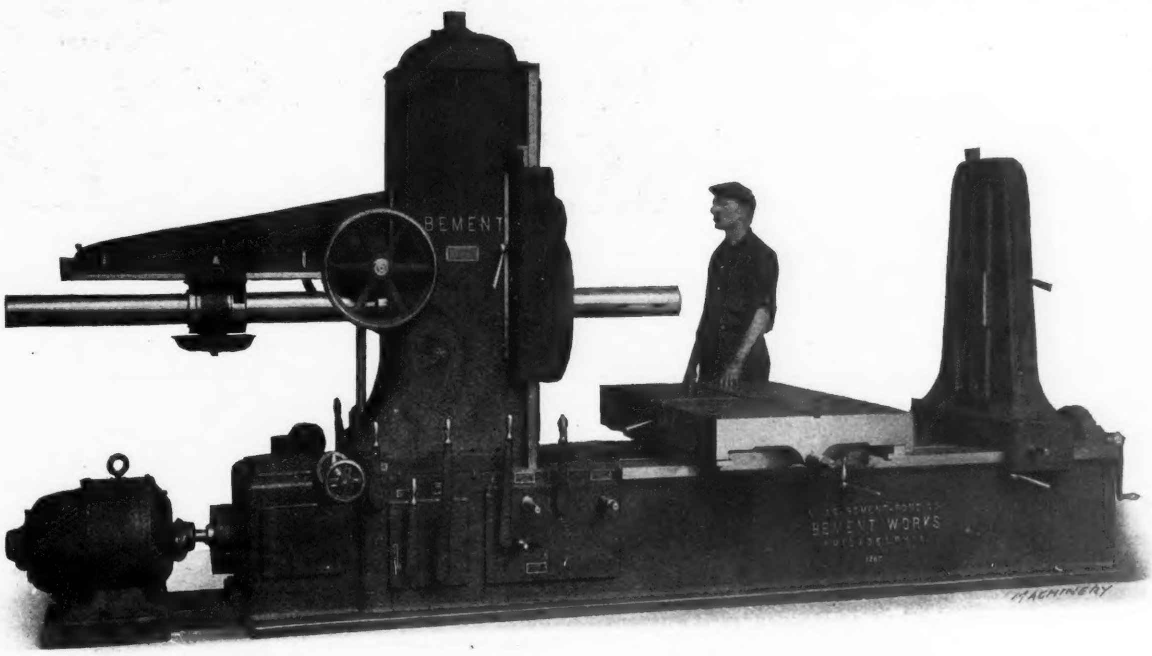


Fig. 1. Niles-Bement-Pond Duplex Control Boring, Drilling and Milling Machine

The Spindle, Saddle and Column

The spindle is of high carbon hammered steel and is lap-ground with great care. It slides in a long sleeve which revolves in removable bearings, the main bearing being tapered so that adjustment can be made for wear. The spindle is driven through two large spline keys set into the sleeve and engaging with keyways in the spindle. It is fed and rapidly traversed by means of a screw in the saddle horn. The front portion of the spindle saddle has long bearings on V-tracks planed on the faces of the column. The V-bearings form the best possible method of preserving the spindle alignment when the saddle is clamped for boring, or sliding vertically for milling. Furthermore, with this construction, the hard back pressure due to boring adds to the truth of the alignment. The saddle has vertical power feeds for milling and also rapid power traverse. This motion is transmitted through a vertical screw which is connected by gearing to a similar screw in the outboard post, so that the spindle saddle and outer bearing always move in unison with each other. The spindle driving gear is enclosed within the saddle, with a portion extending outward and exposed for use as a faceplate.

The spindle column is of box form, open through the center but connected at the bottom in one continuous casting. The column is held at the top by a cap tongued and grooved to it, the whole design making a very rigid structure. It is strengthened inside by ribs located in the best possible manner for resisting backward and torsional strains. V-tracks for the saddle traverse are planed on the front of the column. The tracks have unequal sides; the faces toward the outside of the column are broad for presenting a liberal bearing surface for the saddle; the faces toward the inside are approximately at right angles to the others for resisting side thrusts. The outboard column is made in two parts; the lower portion is adjustable along the bed to which it is gibbed; and the upper part is bolted and doweled to the lower, so that it may be removed for long pieces of work and easily replaced in correct alignment. Provision is made for disconnecting the vertical lifting screw from the rest of the mechanism in order to avoid the necessity of dismantling any of the gearing when it is desired to remove the post.

The Table

The table has a very large working surface with T-slots for holding the work. It is gibbed to a saddle with square locks having adjustment for wear. The table is provided with power cross-feeds for milling and rapid power traverse for quick adjustment. The table slides on a broad saddle long enough to support it at the extreme position of its travel. The table saddle is adjustable along the bed by hand or by power through a screw running through the center between the tracks of the bed. It is gibbed to the bed with square locks having adjustment for wear. Power feeds are provided as follows: horizontal feed of the spindle, suitable for boring and drilling; vertical feed of the spindle saddle and cross-feed of the table for milling. In addition, automatic feed may be provided for the circular motion of the standard table, or in connection with a round table, if ordered. The feed-screws are accurately cut and of large diameter. All feeds are reversible and can be varied through the entire range for each spindle speed. The feeds are not affected in amount per revolution as the spindle speed is changed.

The Bed

The bed is a cored-out box casting, unusually wide at the top and presenting a liberal surface for the table saddle bearing. It has broad flanges at the bottom for support and is braced inside with frequent cross ribs. It is entirely closed at the top to prevent chips from falling inside. Within are the driving, feed and traverse gears. The driving gears run in an oil bath and the feed and traverse gears are lubricated by the splash system. The gearing is readily accessible for examination by removal of large cover plates on both sides of the bed. The bed has been designed to give maximum strength and rigidity so that the machine can be placed where no special foundation is available.

The Facing Head

A facing head can be furnished, which may either be attached to the faceplate gear or fastened on the boring-bar. It is provided with automatic radial feeds by adjustable fingers and star. If required, an additional work support can be supplied, consisting of a comparatively narrow casting which extends across the bed and has adjustment on it. It is of the same height as the regular work-table and has a T-slot in the top surface for clamping. The preferable drive is by a direct-current variable-speed motor of three to one range, but the machine may also be furnished with the following drives: cone pulley and countershaft, single pulley through a speed-box, multi-speed alternating-current motor, or constant-speed alternating-current motor through a speed-box. Inasmuch as the single-pulley and constant-speed alternating-current motor drives require additional gearing, one of the other methods is recommended.

Fig. 2. Opposite Side of Niles-Bement-Pond Machine shown in Fig. 1

GREAVES-KLUSMAN 24-INCH LATHE

The Greaves-Klusman Tool. Co., Cincinnati, Ohio, is now building the 24-inch lathe which is illustrated in Fig. 1. The design of this machine has been carefully worked out to meet the requirements of heavy lathe work and several new features have been applied in its construction. Notable among these, is the quick-change gear-box which is a separate unit bolted to the bed of the machine. The cone of nine gears contained in this box gives the fine changes and these are compounded by a cone of six gears to the left. Threads from ½ to 28 per inch can be cut without requiring the gears to be changed. All gears in the quick-change gear-box are of steel and the cone gears and tumbler gears are cut with a 20-degree pressure angle cutter. The teeth are brought to a sharp point so that they can be readily engaged even when the machine is standing idle. By substituting different change gears on the studs at the head end of the machine, metric and special threads can be cut. The gears in the quick-change gear-box run in a bath of oil.

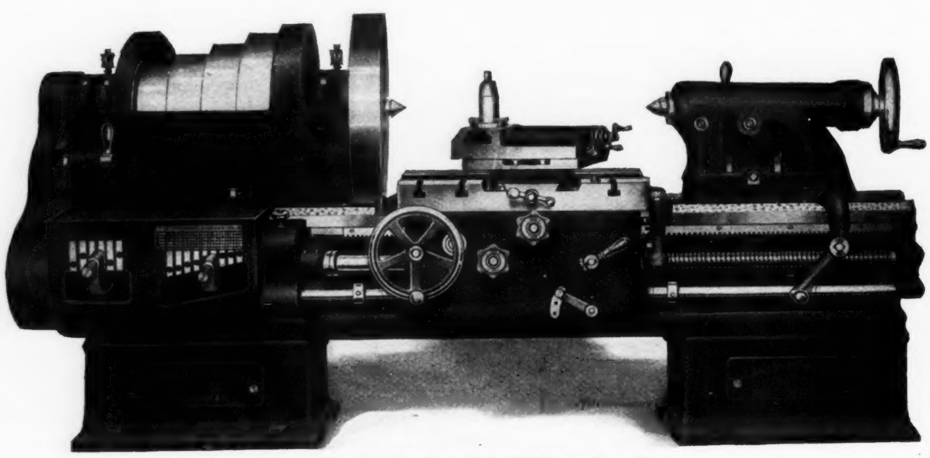


Fig. 1. Greaves-Klusman 24-inch Heavy-duty Lathe

The headstock is of massive construction and heavily webbed for its entire length. The spindle is set back of the center line of the bed. It has hardened bearings at both the front and rear and runs in bronze-bushed boxes which are oiled by sight-feed lubricators. The lower half of the back-gear guard is cast integral with the headstock and the headstock cone pulley is of unusual size, with a wide belt.

The bed is of improved design and heavily reinforced between the vees, these reinforcements extending down below the top of the girths. A heavy wall is cast through the center of the bed and there is a rack on the upper surface

of this wall which engages a pawl attached to the tailstock. This rack and pawl mechanism provides for taking the end thrust on the tailstock when the machine is under heavy cut. The cross-section of the lathe bed is shown in Fig. 2, from which the departure from standard design will be apparent. The ordinary practice has been to make the front and rear vees of equal height so that in leveling up the lathe, the level would be placed on top of the two outer vees. As it is important to have the spindle as close to the bed as the required swing of the lathe will permit, the outer vee at the rear of the machine has been brought to the level of the flat inner bearing at the front. In leveling up the machine, the level is placed on top of this flat surface with its other end resting on the outer vee at the rear of the machine. This design permits the spindle to be lowered ⅞ inch without diminishing the swing over either the shears or carriage.

Another feature of the design is the form of the vee at the front of the machine. Referring to Fig. 2, it will be seen that this is machined with two surfaces on the inside. The lower surface makes an angle of 15 degrees with the perpendicular, while the upper surface is inclined at 45 degrees, thus providing a larger wearing surface for the carriage. With the spindle set back of the center line of the bed, and also lowered by reason of the design of the machine, the line of action of the tool pressure is carried further toward the center of the machine. Assuming that the tool is ground to a standard angle, the tool pressure on the 24-inch lathe falls within the front vee when turning all diameters up to 17 inches. The advantage of this is obvious, as 90 per cent of all work done on a lathe of this size is well under 17 inches in diameter. When the angle of tool pressure falls outside the front vee, the strain is thrown on the carriage and the carriage has a tendency to creep up on the vees, making it necessary to have the gibs snug.

The compound rest is of improved construction. Instead of being rounded at the end, the lower slide is square and is graduated through an arc of 180 degrees on its upper surface. The middle casting is also square. The design gives a very rigid support to the toolpost, and the compound rest can be locked in any position by four locking bolts. The carriage is locked to the bed by a screw and gib which are located as near the center as the compound rest will permit. The apron is designed with a removable front

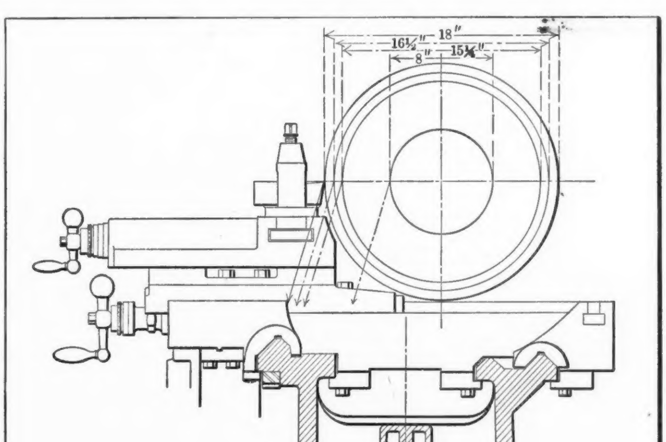


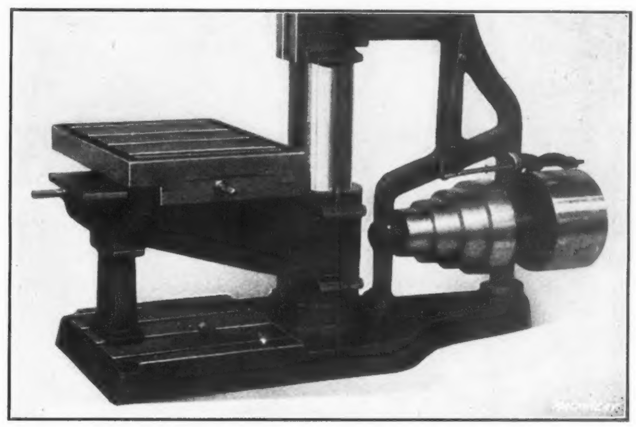
Fig. 2. Cross-sectional View of Greaves-Klusman Lathe Bed

plate so that in case it is desired to examine the mechanism, it is not necessary to remove the apron from the machine. All that is required is to remove the levers and wheels, and then remove the cap-screws and lift off the front plate. To insure alignment, the plate is doweled to the main apron casting. The feed-rod is supported at both ends of the apron so that there can be no unusual wear on the double bevel pinion by reason of sag in the feed-rod. The lead-screw is also supported in the main apron casting by two bearings—one on each side of the lead-screw nut. The lead-screw is 2 inches in diameter and has a two-pitch right-hand single thread. The indicator dial swings free of the lead-screw when not in use for thread cutting, and the usual safety device is provided so that the feed-rod and lead-screw cannot both be engaged at the same time.

The tailstock is of exceptionally heavy construction. It is locked in position by four bolts, all of which are accessible from the front. This lathe is built with either a four-step cone pulley and double back-gears or with a single pulley drive and geared head. The principal dimensions are as follows: Swing over bed, 27½ inches; swing over carriage, 18 inches; maximum distance between centers, 5 feet 6¼ inches; ratio of back-gearing, 12.7 to 1; travel of compound rest, 8½ inches; net weight of machine, 8500 pounds.

AURORA COMPOUND TABLE

The 24-, 26-, 28-, 32- and 36-inch drill presses built by the Aurora Tool Works, Aurora, Ind., can now be provided with the compound table which forms the subject of this article. The design of this table is of unusually heavy construction and the table and saddle slide on bearings of ample width. The working surface of the table built for use on the



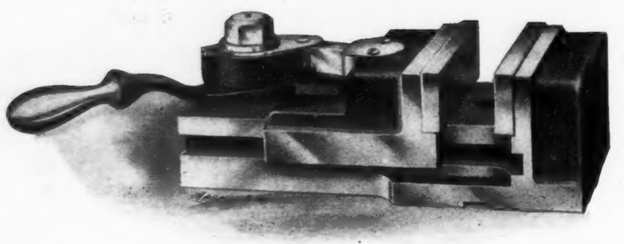
Compound Table built for Use on Aurora Drill Presses

24- and 26-inch machines is 18 by 24 inches, and the table has transverse and longitudinal movements of 15 inches. The compound table for use on the 28- and 32-inch machines has a working surface of 22 by 28 inches, and longitudinal and transverse movements of 17 inches. The table for the 36-inch machine has a working surface of 24 by 30 inches, and longitudinal and transverse movements of 17 inches. The height from the top of the base to the top of the table is 20 inches for all sizes in which this table is built.

In the May, 1913, number of MACHINERY, a 24-inch Aurora upright drill provided with positive geared feed was illustrated and described. This company is now building a machine of similar design in a 22-inch size. The principal dimensions of the new 22-inch machine are as follows: Maximum distance between spindle and table, 30 inches; hole in spindle, No. 4 Morse taper; traverse of spindle, 11 inches; back-gear ratio, 6 to 1; width of belt, 2½ inches; and net weight of machine, 1350 pounds.

CARTER & HAKES QUICK-OPERATING VISE

To meet the demand for a quick-operating vise with a wide opening of the jaws, the Carter & Hakes Co., Sterling Place, Winsted, Conn., has brought out the tool which forms the subject of the present article. For some time, this company has been manufacturing a No. 2 lever vise, and the new product follows very closely along the line of the preceding type as regards dimensions and method of operation. The difference lies in the fact that the new vise is provided with a friction clamp on the operating lever which makes it possible to increase the quick operating movement of the jaw from ⅛ to ¾ inch. This is found particularly useful where the nature of the work requires the use of a vise with a wider opening or where the pieces to be machined have to be located from holes which necessitates the use of pins in the vise jaws. The construction of the vise is such that the friction clamp does the quick operating of the mov-



Carter & Hakes Quick-operating Vise provided with a Friction Clamp

able jaw, while the final and actual holding is accomplished by an eccentric and link mechanism, the same as on the regular Carter & Hakes No. 2 vise.

ROCKFORD PUNCH PRESS STOCK REEL

For handling flat stock for punch presses, the Rockford Iron Works, Rockford, Ill., has recently placed on the market the reel which is shown in the accompanying illustration. This reel is arranged to hold stock up to 4 inches in width and rolls up to 36 inches in diameter. Reference to

Rockford Reel for holding Flat Stock to be fed to Punch Presses

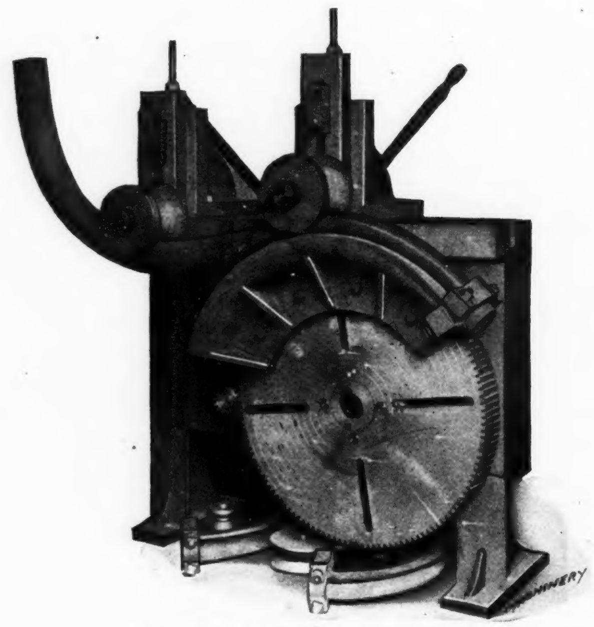
the illustration will show that the reel is adjustable up and down, and the proper tension is obtained by means of a friction disk, so that no difficulty is experienced from having the stock run off the reel faster than it is used up by the press. The illustration makes the construction of this equipment so clear that further description is unnecessary.

PEDRICK PIPE BENDING MACHINE

The demand for a machine to bend large pipe has led the Pedrick Tool & Machine Co., 3639 Lawrence St., Philadelphia, Pa., to develop a machine adapted for this class of work. Fundamentally, there is not a wide divergence between the construction of the present machine and the smaller sizes of pipe-bending machines built by this company. The same principles are employed, but have been modified to suit the conditions met with in bending heavy pipe.

The main frame of the machine is a rectangular casting ribbed on one side and having large bosses to provide the bearings for the gear shafts. An ample gearing ratio permits hand power to be utilized to operate the machine. The pipe to be bent rests in a quadrant which is attached to the faceplate gear. There are two resistance rollers which are adjustable laterally on the bed and also vertically so that they may be brought to bear on the pipe at any desired points.

On this machine it is an easy matter for two men to make a right-angle bend in a 4-inch pipe, the pipe being bent cold and without requiring it to be packed with sand or other filling material. The illustration shows a 4-inch pipe in the machine, bent on an 18½-inch radius, which is some-



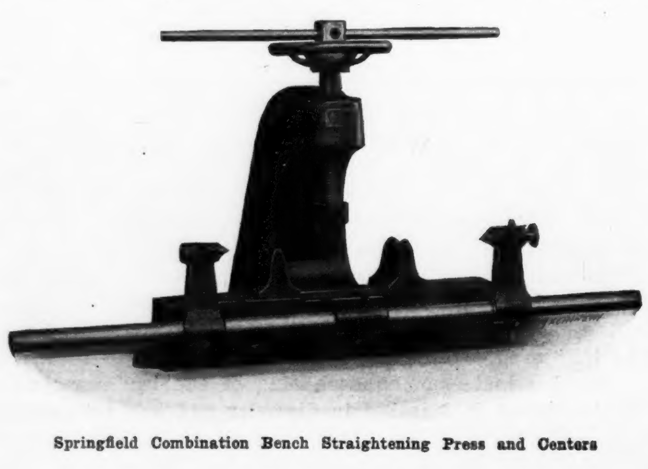
Large Size Pedrick Pipe Bending Machine

what smaller than that usually called for by standard practice. The bends made by the machine are smooth and the section of the pipe remains round, the work being so perfect that it will easily pass the most critical inspection.

SPRINGFIELD BENCH-STRAIGHTENING PRESS

For some years, the Springfield Machine Tool Co., 631 Southern Ave., Springfield, Ohio, has been manufacturing two sizes of bench-straightening presses and centers, known as the Nos. 00 and 0. To meet the demand for a machine adapted for handling heavier work, a No. 1 straightening press of similar design has recently been placed on the market. Reference to the illustration of this machine, which is presented herewith, will show any mechanic the work for which it is adapted without requiring a detailed description to be published. It will be seen that the blocks upon which the work rests while being straightened, are movable to or from the screw and are kept in line by tongues which fit in a groove in the bed of the machine.

The shaft which supports the centers is movable through the arm which carries it, and is held in position by means of a set-screw. This screw has a brass cap over its point to



Springfield Combination Bench Straightening Press and Centers

prevent damaging the shaft. It will also be noted that the positions of the centers can be adjusted along the shaft and that the centers are held in any required position by means of binding screws. The right-hand center is pressed forward against the work by means of a spring and has a knurled knob at its end for pulling the center back when it is desired to put work in place or to remove it. The convenience of this combination straightening press and centers will be readily appreciated by those who have had experience in carrying work back and forth between a straightening press and lathe, in shops where a combination machine is not available. The dimensions of the new No. 1 machine are as follows: Diameter of screw, 2 inches; diameter of centering shaft, 1¾ inch; length of centering shaft, 65 inches; maximum distance between sliding blocks, 13½ inches; maximum distance between centers, 55 inches; maximum diameter of stock which can be straightened, 3½ inches; and net weight of machine, 750 pounds.

NEIL & SMITH PORTABLE ELECTRIC CENTER GRINDER

The accompanying illustrations show a portable electric grinder which has been developed by the Neil & Smith Electric Tool Co., 120-122 East Sixth St., Cincinnati, Ohio, for use in grinding lathe centers. It will be seen that the grinder is provided with a taper shank which fits into the spindle of the tailstock on the lathe, and when so set up the grinder is in position for grinding the live center to the required angle of 60 degrees. The operator is not called upon to adjust the grinder to secure this angle, and the use of this tool is the means of having all centers in the shop brought to a uniform and accurate standard.

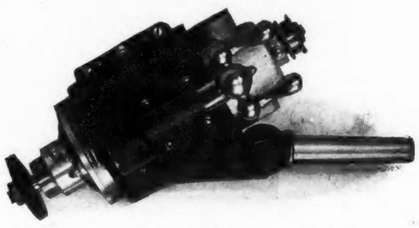


Fig. 1. Neil & Smith Portable Electric Center Grinder

The center of the grinder spindle and the center of the taper shank are exactly in line with each other, and the only condition governing the accuracy to which the center is ground is the alignment of the tailstock with the headstock. For example, consider the case of a lathe that is accurate within the limits of commercial requirements; the live center will be ground accurate within the same limits, which is all that is necessary to secure the degree of accuracy that is required of the work done on the lathe. Means have been provided to make the grinder interchangeable between different sizes of lathes that may be used in a shop. For this purpose, the grinder is provided with a standard size hole and the taper shank that fits in the tailstock spindle has a standard size shank that fits into this hole. As a result, it is merely necessary to order shanks of the proper size to fit the different tailstock spindles of the lathes which are in use in the factory, and all of the centers can then be accurately ground to a uniform angle of 60 degrees.

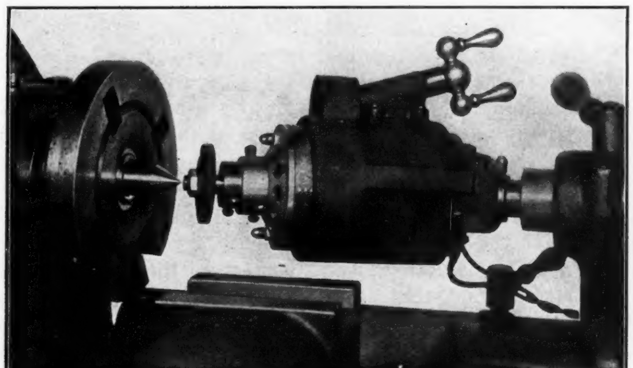


Fig. 2. Neil & Smith Center Grinder set up on a Lathe

Hall Tool-holder for taking a Roughing and Finishing Cut simultaneously

HALL TOOL-HOLDER

The accompanying illustration shows a tool-holder which provides for holding two tools, one of which takes the roughing cut while the other is used for the finishing operation. Referring to the illustration, it will be seen that one of the tools is carried in a head which is integral with the shank, while the second tool is mounted in a head, the position of which is adjustable. The two heads are held together by a dovetailed slide, and the position of the adjustable head is regulated by means of a screw and ball-crank as shown in the illustration. The screw is fitted with a micrometer collar to facilitate making accurate settings. In this way, the relation between the roughing and finishing tools can be adjusted so that the roughing tool leaves just the required amount of stock to be removed by the finishing operation. This new tool-holder is made by Frederick M. Hall of Waterbury, Conn.

NEW BRITAIN BENCH LEG

In order to meet all requirements of a modern manufacturing plant, a bench leg must provide a stiff and rigid construction, without requiring the bench to be dependent upon support from a wall. It must be possible to plank the

New Britain Pressed Steel Bench Leg

bench in a variety of ways; the leg must provide support for an underneath shelf or bin, where such a construction is required; it must be possible to sweep around the bench; and the bench must not interfere with steam pipes that are required to be carried at the back of it. It must also be possible to change the bench from one location to another without damage, should such a change of location become necessary.

Bearing these requirements in mind, the New Britain Machine Co., 64 Bigelow St., New Britain, Conn., has brought

out a pressed steel bench leg which is shown in the accompanying illustration. This company's experience in making gray iron bench legs has shown the value of providing a longitudinal stringer. This construction enables the legs to be placed as far as 8 feet apart and results in a reduction of labor and lumber costs. The stringer affords great rigidity to the back portion of the bench, and prevents deflection and end sway. Additional stiffness is afforded by the back board which is screwed to the face of the upright and forms a screen to prevent work from being pushed off the bench.

The U-shaped section of the legs with the U's facing each other, enables the lower shelf or bin supports to be put in between the flanges of the legs and securely retained in place. Reasonable variation in the height of the leg can be made to meet special conditions, but the stock pattern covers the average requirements of all machine shops.

"NATCO" NO. 30 MULTIPLE SPINDLE DRILL

The National Automatic Tool Co., Richmond, Ind., has just added to its line of multiple spindle drills the No. 30 machine illustrated herewith. This is a large, heavy machine built to meet the demand for a multiple drill capable of carrying a large number of adjustable spindles over a large drilling area. A machine of this type is particularly adapted for such drilling as automobile crank-cases and work of similar nature. The machine illustrated is capable of carrying from two to forty-four adjustable spindles or it may be equipped with cluster boxes carrying from two to ninety spindles. The sizes of heads furnished on this machine are 16 by 30 inches and 16 by 44 inches. The drill shown in the illustration is equipped with a head 16 by 42 inches in size; this machine was furnished to a motor manufacturer for drilling six-cylinder crankcases in one operation. It is built along simple and sturdy lines, and has ample power to drive high-speed drills at their maximum efficiency, regardless of speed.

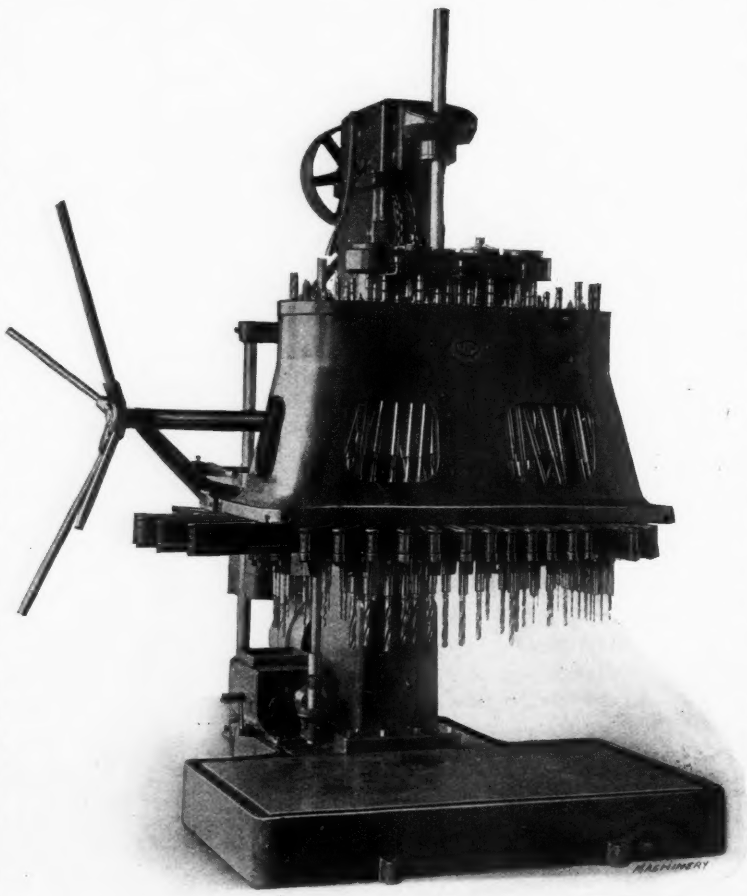


Fig. 1. Front View of "Natco" No. 30 Multiple Spindle Drill

A single-pulley drive is employed so that the machine may be belted to the lineshaft, if so desired, or if individual motor drive is wanted it is easily applied. The driving pulleys are of large diameter and wide face, and are mounted on Hyatt roller bearings. The speed-box is located at the top of the column and three changes of speeds are provided by the sliding gear transmission. The gears are of coarse pitch and wide face, and are hardened and ground. Any one of the three available speeds is obtained by shifting the hand lever to one of the positions marked *A*, *B* and *C*. For each speed obtained from the speed-box there are two independent changes of speeds in the head, made by means of the sliding gearing in the head. These changes are made while the machine is running. The bearings in the speed-box are also provided with Hyatt high-duty roller bearings which insure a high transmission efficiency. The speed-box and feed-box gears are provided with the cascade system of lubrication. There are three independent drill feeds which permit the use of any feed with either of the three double drill speeds that are available in the head. All of the feed changes can be made while the machine is running. The feed-box is located at the base of the column, the feed gears being cut from the solid, hardened and ground. They are of large diameter and run at moderate speeds.

The machine is mounted on a heavy base which is provided with an oil channel for catching the overflow. This channel has a screen pocket through which the cutting lubricant must flow to enter the tank from which it is pumped back to the tools. The pumps employed for oiling the machine and delivering cutting lubricant to the drills are independent of each other. When so desired the base of the machine may be provided with T-slots. Any head which may be furnished on this machine may be equipped with various combinations of adjustable spindles and cluster boxes for drills ranging in size from 1/8 to 1 inch in diameter. The head is provided with power feed and with a pilot arm to facilitate advancing and returning it easily and rapidly. The power feed may be tripped either automatically or by hand. The head is counterbalanced by means of three chains which support a counterweight within the column and also additional sectional counterweighting in the rear of the machine to compensate for the variations in the number of arms used.

The column is heavy and rigid, and is of box section. The spindles are made of special steel, hardened and ground, and are provided with ball thrust bearings at the lower end and lock-nuts at the upper end to take up any end wear that may develop. The spindles are made to carry either straight shank or Morse taper shank drills, as required. Individual flexible oil tubes deliver the cutting lubricant to each drill when the machine is working on steel or aluminum. The bronze bearings which carry the drill spindles are provided with a vertical adjustment to compensate for variation in drill lengths. This adjustment is secured by simply loosening one nut which is so located as to be always accessible. When vertical adjustment is needed it is not necessary to move any arm from its set position. This spindle adjustment is a patented construction and holds the bearing rigidly to the end of the arm; and the arm may be moved to cover any layout within the range of the head. The universal joints used on all "Natco" drills are milled from the solid and carefully hardened. They are composed of only five pieces. These universal joints are guaranteed for two years.

One of the most important features of this machine, which is used exclusively on "Natco" drills, is the independent drill speeds in the head which give two independent changes of speed to each spindle for each of the three changes of speeds obtained in the gear-box. This enables large and small holes to be drilled simultaneously at correct cutting speeds. It is a recognized fact that it is impractical to drive drills of different sizes at the same speed or feed per revolution. The "Natco" independent drill speed feature gives approximately the correct speed and feed for each size drill that comes within the range of the machine. For example, using 1/2- and 1-inch

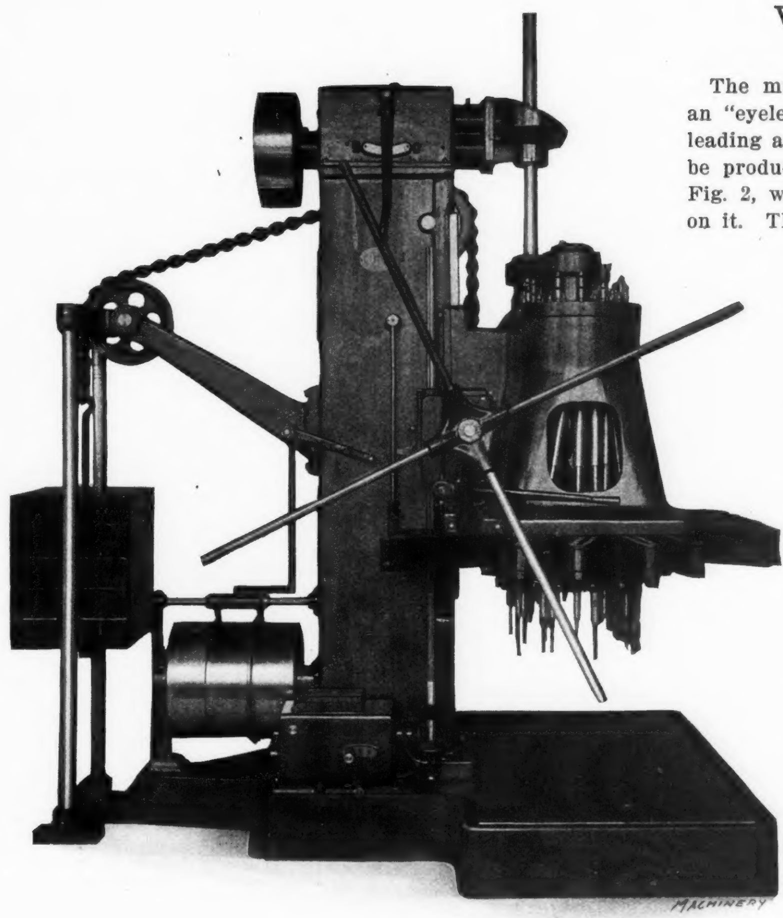


Fig. 2. Side View of "Natco" Drill shown in Fig. 1

drills in cast iron, it is possible to secure a feed of 4.72 inches per minute. For this purpose the speed-box lever is shifted to *B* which gives 547 revolutions per minute, or 71.5 feet per minute as the peripheral feed of the ½-inch drills which are fed at 0.0086 inch per revolution. By shifting the driving pinion in the head which drives the 1-inch drills, these drills can be driven at 271 revolutions per minute, or 71 feet per minute at a feed per revolution of 0.0174 inch. The peripheral velocity of the drills in feed per revolution is practically the same, while the feed of the ½-inch drills is only one-half as great as that of the 1-inch drills.

LUFKIN TAPE THREADER

Those who have had experience in the use of woven or steel measuring tapes, know that the case in which the tape is rolled up when not in use lasts much longer than the tape itself. This is due to the fact that metal tapes are quite easily broken and the woven tapes become frayed at the edges while the case is still quite good. As the case represents approximately half the cost of the complete outfit, it is obviously a desirable feature to be able to put a new tape in an old case. For this purpose, the Lufkin Rule Co., Saginaw, Mich., has developed a device styled a "tape threader" which enables a new tape to be inserted in a case in this way. It consists of a loop and stud arrangement by means of which the old tape may be readily detached from the winding drum in the case and a new tape secured to the winding drum in its place. One of these threaders will now be furnished with all measuring tapes sold by the Lufkin Rule Co., thus effecting a marked economy through the possibility of fitting new tapes into old cases when necessary.

WATERBURY-FARREL EYELET MACHINES

The multiple-plunger press illustrated in Fig. 1 is styled an "eyelet machine," but this name is really somewhat misleading as a great variety of products other than eyelets can be produced. This fact will be emphasized by reference to Fig. 2, which shows some products that are regularly made on it. The illustration is about one-fourth size, and bearing this fact in mind manufacturers who produce articles of the character for which this machine is adapted will be able to gain an idea of its capacity. The following description will make it clear that work which involves cutting a blank from sheet metal and then performing subsequent drawing, forming, piercing, clipping and similar operations on it, can be handled in an efficient manner.

Referring again to Fig. 1, it will be seen that the machine is essentially a multiple-plunger press. Different numbers of plungers are built into a single frame, each plunger performing a special operation; a carrier is provided to transfer the work from plunger to plunger. As all operations are performed in rapid succession, the expense of handling is reduced, and annealing the work—which is frequently required where individual presses are used—is avoided. Experience has shown that four plungers is about the smallest number that can be used to advantage, although three plungers are successfully employed in certain cases. The standard machines are built with from four to eight plungers, and manufacturers are advised to purchase machines with at least six plungers. Where this number of plungers is not required, the work can still be handled with exactly the same efficiency, as the plungers not in use remain idle. To meet special requirements, machines can be built with nine or ten plungers.

The operation of the machine is as follows: The stock in the form of a strip of uniform width is carried on a reel at the front of the machine. Before entering the machine the stock passes over a lubricating sponge box and then through a guide to a pair of intermittent ratchet feed rolls. While the feed is at rest, the first blanking plunger cuts out the

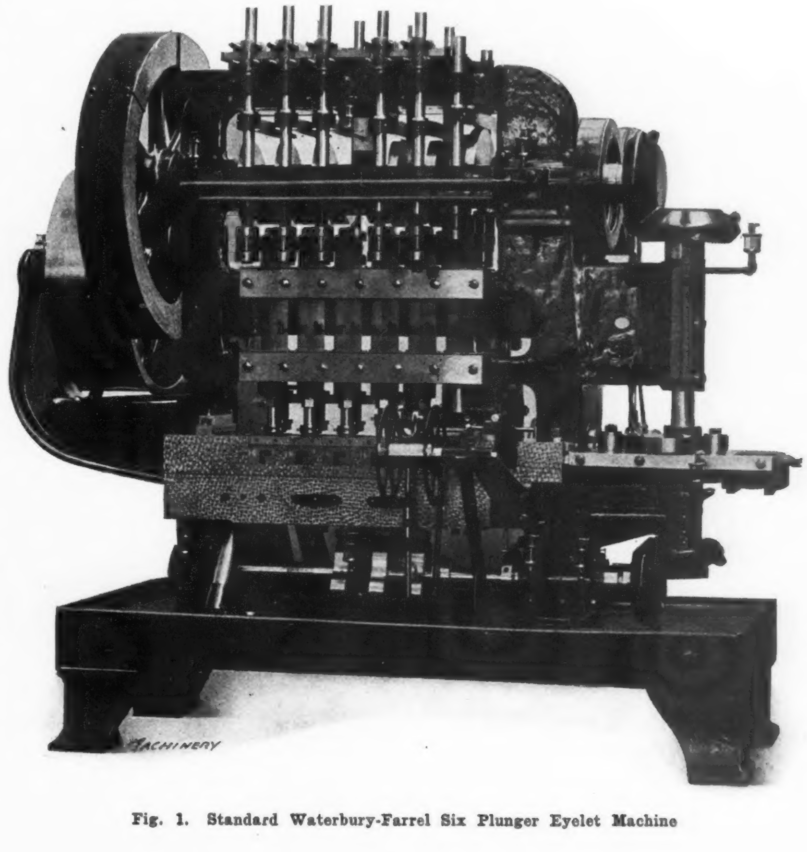


Fig. 1. Standard Waterbury-Farrel Six Plunger Eyelet Machine

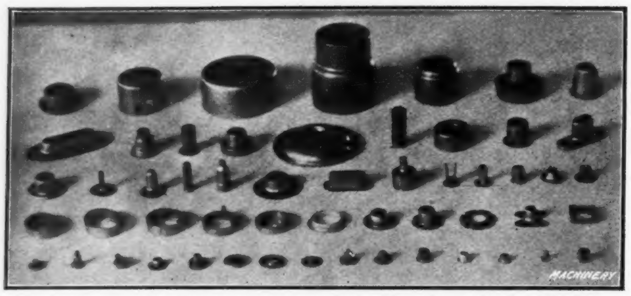


Fig. 2. Examples of Work done by Waterbury-Farrel Eyelet Machine

blank on its downward stroke and carries it through the die into a socket in the transfer slide. The scrap metal goes on through the machine and is rolled up on a second reel. The transfer slide is then moved to the left by the action of the side camshaft and carries the blank to the second plunger. At this point the second plunger with its forming punch comes down and draws the blank through the transfer slide into the first cupping die. The transfer slide now recedes and on the up-stroke of the second plunger a knockout, which is actuated by a cam motion on the lower shaft, pushes the shell out of the die into a pair of fingers held on the transfer slide. The next advance of the transfer slide carries the work on to the third plunger and at the same time brings a second blank forward to the second plunger. This sequence of operations continues until the work is completed, when it drops out through a delivery tube located at the left-hand side of the machine. Similar tubes are provided at each station where piercing or clipping operations are performed, which deliver the scrap metal into retainers placed in a convenient position to receive it.

It is not within the scope of this article to enter into detail in regard to the design and construction of the machine. Let it suffice to say that the noteworthy improvements consist of the substitution of a cam-actuated transfer slide in place of the old crank-operated slide. This change was made to eliminate trouble resulting from the use of a crank for this purpose, which was found to be noisy, unmechanical and to give trouble on account of the liability of the side stud to break, thus resulting in a loss of time and frequent damage to the tools. An improved form of adjustable stripper is also used and improved fingers on the transfer slide provide for moving the work from plunger to plunger for the various operations.

Machines of this type are made in seven different sizes. This does not refer to the number of plungers on the press but to the distance from center to center of the plungers and the stroke of the cams. Machines of each size are made with the different numbers of plungers referred to in a previous article. The smallest machine of the series has a distance of 1¾ inch from center to center of the plungers and a standard stroke of the cams of 1¼ inch; the largest machine has a distance of 5 inches from center to center of the plungers and the stroke of the cams is 4½ inches. These machines are built by the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn.

CIRCULAR ATTACHMENT FOR CLEVELAND PLANERS

Cleveland Planer Works, 3150-3152 Superior Ave., Cleveland, Ohio, recently built a circular planing attachment for use on a Cleveland planer used in the works of a bridge and iron company. The planer equipped with this circular attachment is illustrated in Fig. 1, and Fig. 2 shows a closer view of the circular table. Curved work with radii ranging from 5 to 15 feet can be planed on this attachment by adjusting the position of the center about which the circular table swings to different points on the truss which supports the center. In order to provide for planing a surface at an angle, as would be necessary on curved tracks and similar work, a special planing head is provided which can be set to different angles. This head is clearly shown in the illustration.

There is a stud set in the regular planer table and a second stud in the circular table, these two studs being connected by a link. In this way the circular table is drawn back and forth by the planer table. The circular table is held down on the planer table by means of extension plates. Thus, the circular table is free to swing on the required arc when the center about which it swings is adjusted to different positions on the horizontal truss. The work to be planed is fastened to the circular table in the usual way, by means of T-slots and bolts.

Fig. 1. Cleveland Planer equipped with Circular Planing Attachment

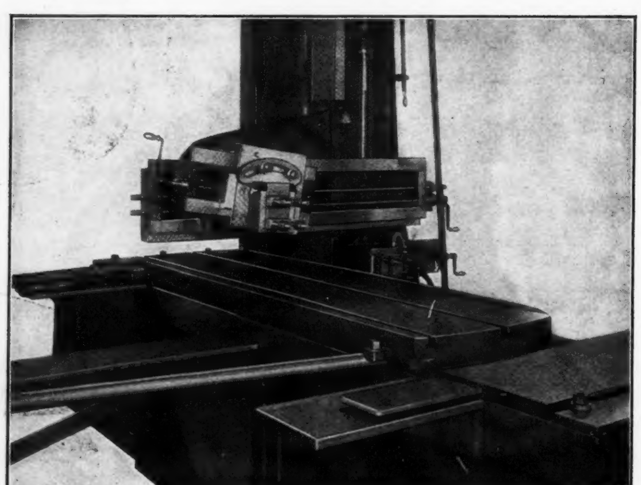


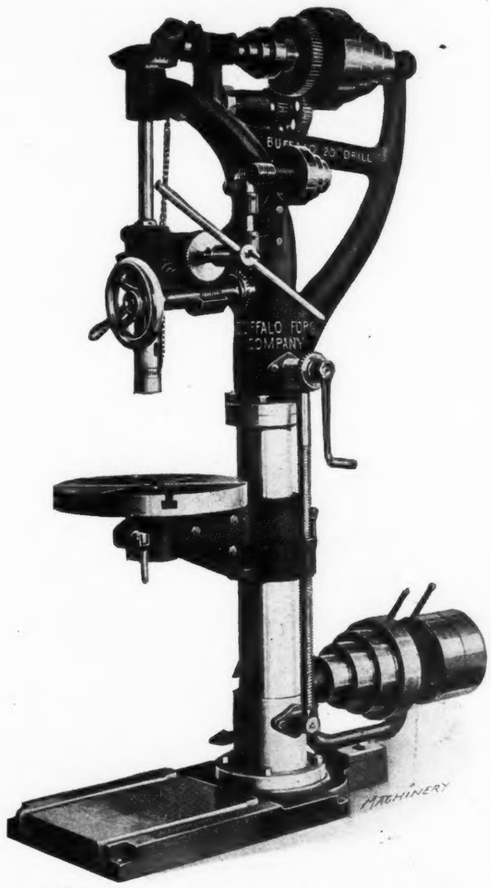
Fig. 2. Close View of Cleveland Circular Planing Table

BUFFALO UPRIGHT DRILL

One of the latest products brought out by the Buffalo Forge Co., Buffalo, N. Y., consists of a 20-inch upright drill which is shown in the accompanying illustration. It will be seen by referring to the engraving, that the table of this machine is raised or lowered by means of a screw and handwheel; this screw is provided with a ball-thrust bearing at its lower end so as to make the movement of the table as smooth and easy as possible. In order to provide

for handling large work, the design is such that the table can be swung out of the way; T-slots are machined in the base of the drill and large work can be secured in place on the base.

This drill press is equipped with either lever, wheel or power feed. In order to provide suitable leverages for various drilling operations, the position of the hand lever in the hub is made adjustable. A spring is located in a socket in this hub and the pressure provided in this way is sufficient to hold the lever in any required position. Suppose the operator is changing the drill press over for a heavier operation. It is merely necessary for him to pull the lever out to a position which will give the required leverage and the spring will then hold it in this position. Where one class of work is to be handled for a considerable length of time, the lever can be permanently clamped in place by tightening up a wing nut.



Buffalo 20-inch Drill equipped with Wheel, Lever or Power Feed

For using either the wheel or power feed, the worm is brought into engagement with the worm-wheel and held in place by means of a latch located at the left-hand side of the machine. The arrangement of the drive will be readily understood from the illustration without requiring further description. It will, of course, be evident that when the wheel feed is used the worm is rotated by turning the handwheel. When it is desired to use the power feed, it is necessary to tighten up a screw at the front of the handwheel hub. This draws up a friction in the bevel gear which transmits power to the worm, and in this way the power feed is secured, doing away with the necessity of rotating the worm by means of the handwheel.

Another feature of this machine is the ease with which the back-gears may be engaged or disengaged. To throw the gears into engagement, it is merely necessary to operate a small lever located near the top of the machine on the left-hand side. This brings the gears into mesh. When it is required to drive direct, the back-gears are disengaged. Located on the end of the pulley shaft, there is a disk which has a hole in it to receive a tapered pin. This pin is carried in the gear at the end of the horizontal shaft at the top of the drill press, and by entering the pin in the hole in the disk, the direct drive is secured.

The spindle is mounted in ball bearings and is counterweighted inside the column of the machine. It will be seen that the column is made in two sections which are bolted together. Ample strength is secured in this way and a considerable advantage in machining the drill press columns is secured by having smaller castings to work with. The machine can be arranged for belt drive, for direct-connected motor drive or for individual motor drive with the power transmitted from the motor to the pulley of the machine by belt. The principal dimensions are as follows: Maximum distance between spindle and base, 41½ inches; maximum distance between spindle and table, 25½ inches; drills to the center of a 20-inch circle; available feeds, 0.004, 0.007 and 0.012 inch per revolution; maximum movement of spindle, 8¼ inches; spindle bored for No. 3 Morse taper; and weight of machine, 725 pounds.

RICKERT-SHAFER TAPPING MACHINE

The Rickert-Shafer Co., Erie, Pa., has recently added to its line a tapping machine the design of which marks a departure from that of other tapping machines. The drive is of the friction type, the mechanism consisting of a metallic disk mounted between two friction driving wheels. The metal disk is of aluminum and the driving wheels of friction board. By moving the work forward, the disk is thrown against the rear or tapping friction, while pulling the work backward brings the disk into contact with the forward or reverse friction wheel. The friction wheels are mounted at right angles to the disk, as shown in the illustration, and are beveled at such an angle that the maximum pulling power is secured.

Rickert-Shafer Horizontal Tapping Machine with Friction Drive

Another interesting feature of the machine is that it is driven by a single belt which comes down around the rear or tapping friction wheel and then up around the front or reverse friction wheel. It will be evident from this description that both of the friction wheels rotate in the same direction and the reversal of the tap is due to the fact that the disk engages the friction wheels on opposite sides. The

standard equipment consists of a small work-table provided with a stop which can be swung out of the way when not wanted, and with an auxiliary work-slide of the vertical type against which flat work can be held. This slide is provided with a small stop collar. The machine has a capacity of 5/16 inch and of ½ inch for re-tapping. It is built with a base as shown in the illustration or as a bench type machine.

SELLEW AUXILIARY DRILL HEAD

The auxiliary drill head shown in the accompanying illustrations is the latest product of the Sellew Machine Tool Co., Pawtucket, R. I. This is known as the Sellew "straight line," adjustable drill head because the spindles are placed in a straight line. Experience has shown that there is almost

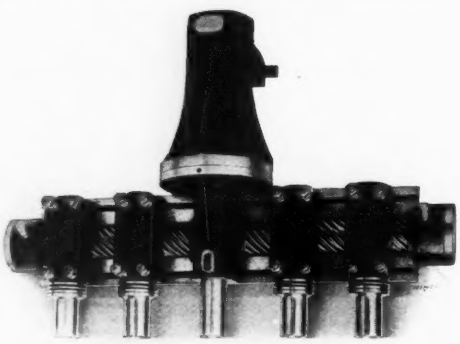


Fig. 1. Sellew "Straight Line" Auxiliary Drill Head

as much drilling done in a straight line as in circular formations but up to the present, no auxiliary drill head has been made with the drills located in this way. The head consists of a main casting or rail, upon which the spindle boxes are bolted and means are provided for adjusting the positions of the spindles along the rail. The rail is bolted to a sleeve which connects it to the drill press, the sleeve being split at its upper end for clamping to the quill of the drill press spindle. This sleeve is interchangeable with other types of adjustable drill heads made by this company. This is a feature of particular advantage, where different heads are to be used on the same machine.

It will be seen that the drill spindle intermediate gear is mounted in a horizontal position on the rail; this gear is

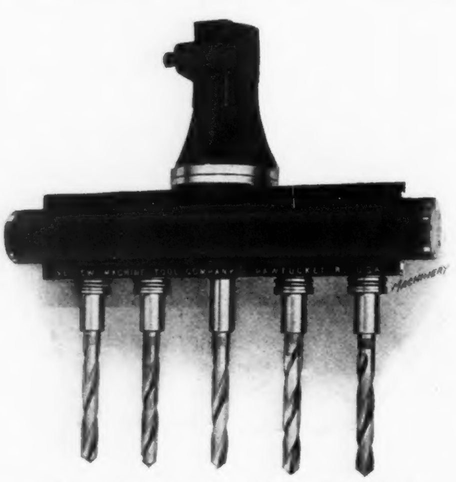


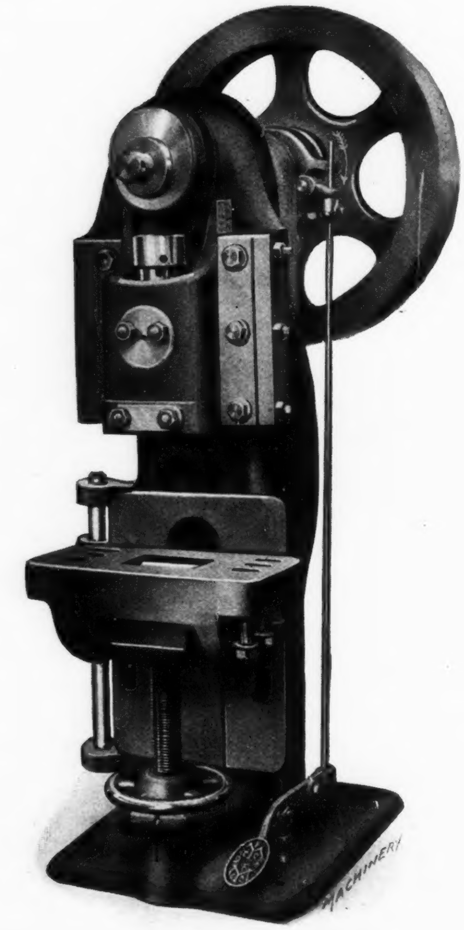
Fig. 2. Opposite Side of Sellew Drill Head

mounted in double annular ball bearings at the center, while annular and thrust ball bearings are used at each end. It is driven by the center spindle which fits into the taper hole of the spindle of the drill press. The spindles on the head are provided with Morse taper holes and they are mounted in bronze bushed bearings. The thrust is taken by ball bearings. The spiral gears on the spindles are enclosed. This head is made in three sizes, known as Nos. 1, 2 and 3, the smallest of which is suitable for use on sensitive drilling machines fitted with small drill chucks. The medium size is arranged for use with either drill chucks or No. 1 Morse taper sockets, while the largest head is suitable for use with No. 2 Morse taper sockets. The range of center distances of these heads is from 1 inch up to 18 inches and is dependent upon the length of the rail. The head is so arranged that it can be used for tapping as well as drilling operations.

FERRACUTE ADJUSTABLE BED PRESS

The Ferracute Machine Co., Bridgeton, N. J., is now building a series of punch presses provided with adjustable beds. The illustration shows the style PA3 press which is the third size; there are six presses in the series. Above the throat, the design of these presses is the same as that of preceding machines built by this company. They have heavy flywheels mounted on shafts which run in phosphor-bronze bearings, pin-clutches and 50-point carbon steel shafts.

The bed of the style PA3 press is supported by a 3-inch steel stud and bolted to the frame by four 1⅜-inch steel bolts. An adjustment of 11 inches from the standard height is provided which, added to the 3-inch ram adjustment, gives a total adjustment of 14 inches. This makes the press particularly suitable for use in connection with a variety of high dies.



Ferracute Adjustable Bed Punch Press

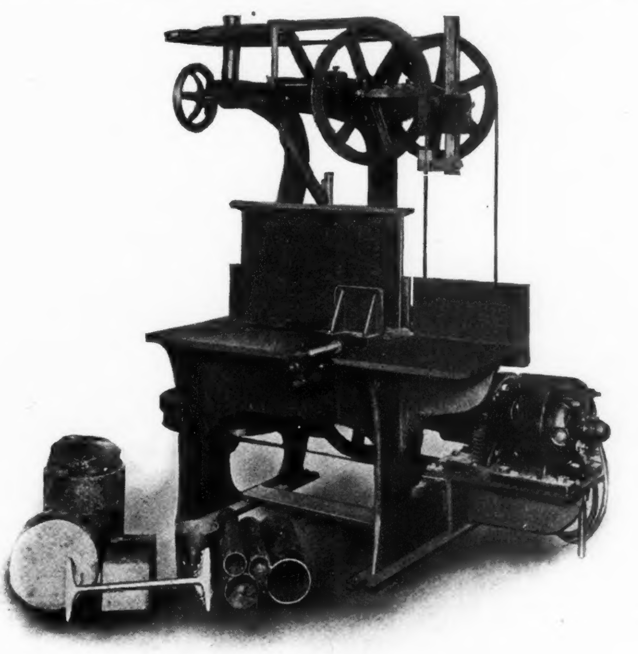
A hinge at the side of the press enables the bed to be swung out of the way when the machine is to be used as a horning press. The principal dimensions of the machine are as follows: Diameter of horn-hole, 6 inches; height from the top of the horn-hole to the bottom of the ram at the top stroke and adjustment, 7 inches; size of hole in bed, 7 by 4 inches; pressure exerted by style PA3 press, 35 tons; and weight of machine, including bolster plate, 4900 pounds.

WILLIAMSON METAL-CUTTING BAND SAW

The Williamson metal-cutting band saw which is illustrated herewith is built by H. C. Williamson, 1840 West Lake St., Chicago, Ill. The construction of this machine is such that any length of stock can be cut off, the wheels being so arranged that the "idle side" of the saw is carried back over

a wheel located directly behind the wheel over which the "cutting side" of the saw runs. The table is provided with holes for strapping work in place and the swivel back and vise provide for cutting at any desired angle. When so desired, the vise and back can be removed from the table to leave a perfectly flat surface on which special work can be held. The operation of the machine is said to be so simple that an apprentice can run it, as the feed is automatic and the machine practically takes care of itself after it has been started. An automatic stop shuts off the power when the cut is finished. When idle, the frame which supports the wheels over which the saw runs stands upright. In starting a cut, the operator takes hold of a handle at the front of the frame and draws it forward to bring the saw into contact with the work. The machine then feeds itself by the action of gravity without requiring further attention from the operator.

As previously stated, an automatic stop shuts off the power when the cut is finished, and a spring retards the forward movement of the frame so that an even feed pressure is secured at all times. The pulleys are flanged so that the saw never runs off, and a handwheel provides for tightening the saw to the required tension. Ample adjustment is provided,



H. C. Williamson Metal-cutting Band Saw

and in the event of the saw breaking, it can be brazed together and continue to give good service. It is said that a tooth is very seldom broken from a blade used on this machine and that a ½-inch round bar can be cut off just as satisfactorily as a bar 10 inches in diameter. Tool steel can be cut as well as soft steel and the capacity of the machine is for structural steel up to the size of a 12-inch I-beam or round bars up to 10 inches in diameter. An idea of the rate at which cutting is done may be gathered from the fact that the machine will cut a 3-inch round bar in 7 minutes. A convenient feature of this machine is that the table is only 20 inches above the floor level, so that it is an easy matter to handle heavy bars, axles, etc., which are to be cut. The power requirements of the machine are exceptionally low, only one-half horsepower being required to drive the saw. The principal dimensions are as follows: Size of blade, 20 feet 9 inches long by ⅝ inch wide; floor space occupied by machine, 36 by 50 inches; weight, approximately 900 pounds.

WESTERN ELEVATING PLATFORM TRUCK

The Western Tool & Mfg. Co., Springfield, Ohio, has added to its line of shop furniture the elevating platform truck which is illustrated in Figs. 1 and 2. Referring to these illustrations, it will be noted that the usual form of auxiliary loading platform is used in connection with this truck. Fig. 1 shows a truck under the platform with the handle pulled down into the "running position." With the handle in this position, the auxiliary platform is raised so that the skids are clear of the floor and the load on the platform can be pulled along by the truck.

In Fig. 2, the handle has been raised to the vertical position. This allows the truck to drop, causing the skids under

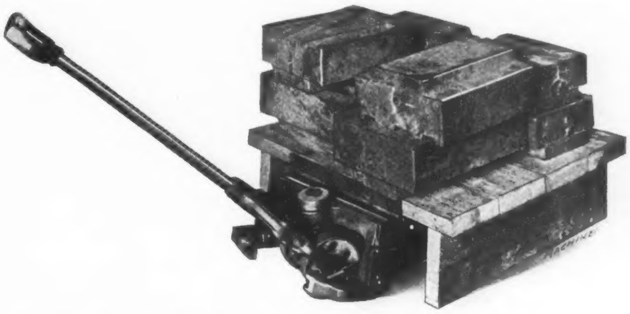


Fig. 1. Western Elevating Truck with Handle in "Running Position"

the auxiliary platform to rest on the floor. The truck can then be drawn out from under the platform and taken to some other location, where it may be required. It will be evident that this form of truck enables cheap loading platforms to be used for storage purposes and only a sufficient number of trucks for transferring material about the plant need be purchased. The top of the Western truck is 17 by 23 inches in size and it elevates 1½ inch. The wheels run on roller bearings and the swivel joint is also provided with a roller bearing. The truck is built along exceptionally strong lines so that it will wear almost indefinitely.

EPICASSIT—A PROTECTIVE METAL COATING

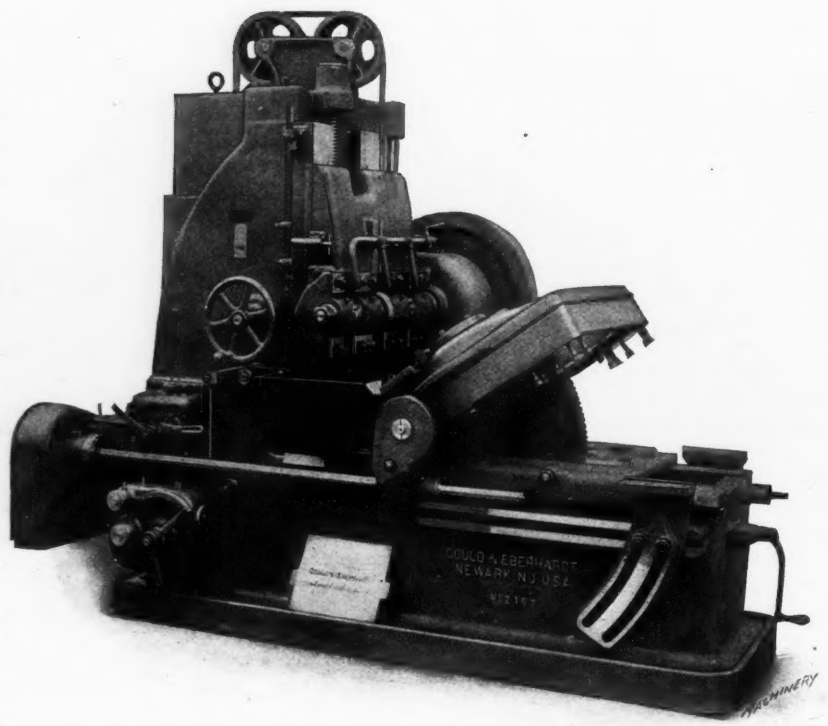
Epicassit is a German material which serves to protect metals against corrosion. It consists of pure tin, pure lead or an alloy of these two metals in various proportions. An alloy of lead, tin and zinc can also be used satisfactorily. The metal is reduced to a powdered condition and this

Fig. 2. Truck shown in Fig. 1 with Handle raised to lower Load to Floor

powder is mixed with "Epicassit fluid" to the consistency of a thick, creamy paint. This is applied with a stiff bristle brush and then melted onto the surface to be coated by heating the article. Any clean source of heat may be employed, such as a blow-torch, a clean fire or an oven. The coating will not run any more than paint, thus making it possible to cover vertical or inverted surfaces with a protective coating of tin, lead or zinc.

Epicassit does not compete with dip-coating methods, where such methods are available, but it covers a peculiar field of

its own. Structural iron work, water tanks and towers, bridges and many other classes of metal work may be galvanized after erection, thus giving them a high resistance against damage from water, acid, ammoniacal fumes or salt water. The damage done in the erecting field to stock which has been galvanized at the mill may also be repaired with Epicassit. No subsequent painting is necessary, but when painting is desirable, the Epicassit sub-surface will prevent blistering or flaking off of the paint, which is usually caused from rusting of the metal under the paint. As Epicassit takes paint well, it effects an economy in both paint and labor.



Gould & Eberhardt Vertical Cutting Multiple-spindle Gear-cutting Machine

In making local repairs of vats, tanks, etc., or in entirely recoating worn surfaces, Epicassit is particularly useful, as it avoids the necessity of dismantling the equipment, shipping it to the dipping plant, and then remounting it. Aside from the cost of freight and labor incident to such a method of procedure, the saving of time which results is a very important factor. It has also been found that babbitt adheres more securely to cast-iron bearing boxes which have been given a preliminary coating of this material. Soldering of cast iron is also greatly facilitated where a sub-surface of Epicassit is used. Hess & Son, 1031 Chestnut St., Philadelphia, Pa., are American agents for this product which has been in successful use in Germany for a number of years.

BARNES SCREW-CUTTING ENGINE LATHE

The screw-cutting engine lathe, front and end views of which are shown in Figs. 1 and 2, is the latest product of the W. F. & John Barnes Co., 231 Ruby St., Rockford, Ill. In designing this machine, the requirements of the garage and repair shop were borne in mind, in addition to the work done by a lathe of this type in manufacturing plants. Ample strength and convenience of operation are provided. The machine is known as the 16–18-inch lathe, not because it is a gap lathe but with the idea of giving the exact swing. Most 16-inch lathes swing from 16½ to 18 inches, and as a result the purchaser does not know what swing his machine has until he has had an opportunity of going over its dimensions.

The head is back-geared in the ratio of 9¼ to 1. The spindle runs in bronze-bushed bearings, and the hole through the spindle is 1⅝ inch in diameter. The taper hole is bored No. 3 Morse taper. The machine has a capacity for cutting from 1 to 56 threads per inch. The lead-screw is 1 7/16 inch in diameter. Shifting a lever to the right or left provides four changes of feed without the necessity of changing gears. With this lever the feed can be instantly reversed; the cross-feed of the tool carriage is governed in the same way. The regular equipment of the machine consists of one large and one small faceplate, one center-rest, two tool-steel centers, a set of eighteen gears which provide for cutting the range of threads previously mentioned, a countershaft and the necessary wrenches. A taper attachment and follow-rest can also be provided for use on this machine. The principal dimensions are as follows: Swing over bed, 18 inches; and swing over carriage, 12 inches. When made with a 6-foot bed, the machine has a maximum capacity of 2 feet 8 inches between centers, and a net weight of 1815 pounds. Built with an 8-foot bed, the lathe has a capacity of 4 feet 8 inches between centers and a net weight of 2025 pounds.

GOULD & EBERHARDT MULTIPLE-SPINDLE GEAR-CUTTING MACHINE

In the February, 1911, number of MACHINERY, a 24 by 8 inch vertical cutting multiple-spindle gear-cutting machine built by Gould & Eberhardt, Newark, N. J., was illustrated and described. This company has recently added to its line a

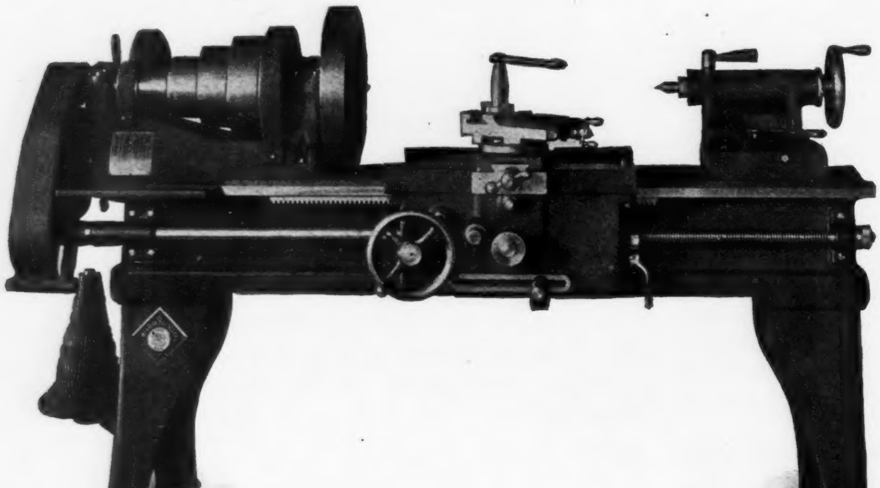


Fig. 1. Front View of W. F. & John Barnes Screw-cutting Engine Lathe

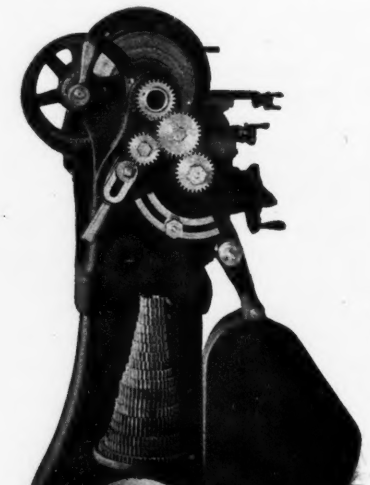


Fig. 2. End View of Lathe shown in Fig. 1

machine of similar design. The new machine is much larger, however, as it is rated at 60 by 16 inches when furnished for cutting spur gears, and at 48 by 12 inches when built for cutting both spur and bevel gears. The capacity of this machine is for cutting up to 1½ diametral pitch in cast iron and 2 diametral pitch in steel. The illustration shows the 48 by 12 inch combination spur and bevel gear machine equipped with a multiple-spindle head attachment for roughing out two large bevel gears at a time. The machine is built for use in roughing out bevel gears for automobile trucks, and meets the requirements of work that is too heavy for the smaller machine which was described in the article previously referred to. The design has been improved in certain respects so that the new machine not only has a greater capacity but is a more efficient producer.

The design of the base and stanchion is the same as in the smaller machine, that is, they are cast in one piece. This provides a rigid structure on which to mount the cutter-slide. The base is designed to give ample support to the work-table and when furnished for cutting bevel gears, the table is provided with rigid supports on each side of the base, which may be adjusted to suit the various angles of the table. The machine shown in the illustration was photographed with these supports disconnected from the table, but the idea will be apparent from the illustration. The supports, acting in conjunction with the worm, worm sector and the clamping screw, assure a rigid support for the work. The cutter-slide is exceptionally long, giving a long narrow guide to the cutter; this tends to maintain a more permanent alignment of the cutter-slide than would otherwise be possible.

The large flywheel at one end of the cutter-spindle serves to equalize the action of the cutter and increase the efficiency of the machine. The vertical cutting or anvil principle works out particularly well on this large machine, the heavy gear blanks when resting in a horizontal position being very securely held for cutting. The weight of the blank is evenly distributed over the table and the entire rim is adequately supported. In the case of two bevel gears which are to be roughed out at one time—for which purpose the machine shown in the illustration is intended—the blanks are mounted on the tilted table and the entire rim or face of the blank is backed up by means of special hardened plates. The vertical cutting principle necessitates tilting the work-slide less than if the cutter-slide tilted with the work held on a horizontal mandrel.

As already stated, the machine is designed along the same lines as the smaller size of vertical-cutting gear-cutting machines built by Gould & Eberhardt. It is provided with a positive indexing mechanism; a quick-change feed gear-box, which gives sixteen changes of feed arranged in geometrical progression; a safety lever mechanism whereby the movements of the cutter-slide and indexing of the work-table are interlocked, so that one cannot operate while the other is in action. All gears are of hardened steel; all bearings receiving thrust loads are equipped with ball thrust bearings; the drive is through a single pulley; and all exposed parts of the mechanism are adequately protected to provide for the safety of the operator.

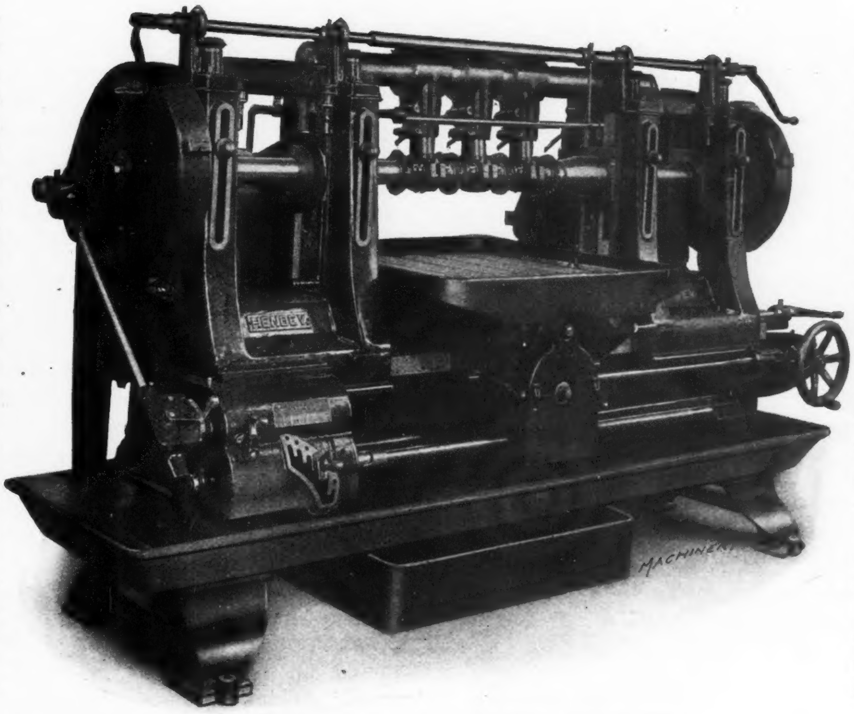


Fig. 1. Front View of Hendey No. 16 Duplex Lincoln Miller

HENDEY NO. 16 DUPLEX LINCOLN MILLER

The No. 16 duplex Lincoln miller, front and rear views of which are shown in Figs. 1 and 2, is a recent product of the Hendey Machine Co., Torrington, Conn. This machine is of exceptionally heavy design to adapt it for the most exacting requirements of high-speed production. The bed has an extra wide top with a square lock for supporting and aligning the headstocks and saddle. The main spindles of the machine have tapered journals on the front ends which run in annular bearings lined with Lumen metal; the spindles are bored No. 12 Brown & Sharpe taper and the noses are threaded. An arched bar is cast integral with the power shaft bearings to assist in maintaining their alignment. The spindles have unit control to provide for elevating or lowering them simultaneously. The overhead arm or tie-bar has three pendants for supporting the arbor, these pend-

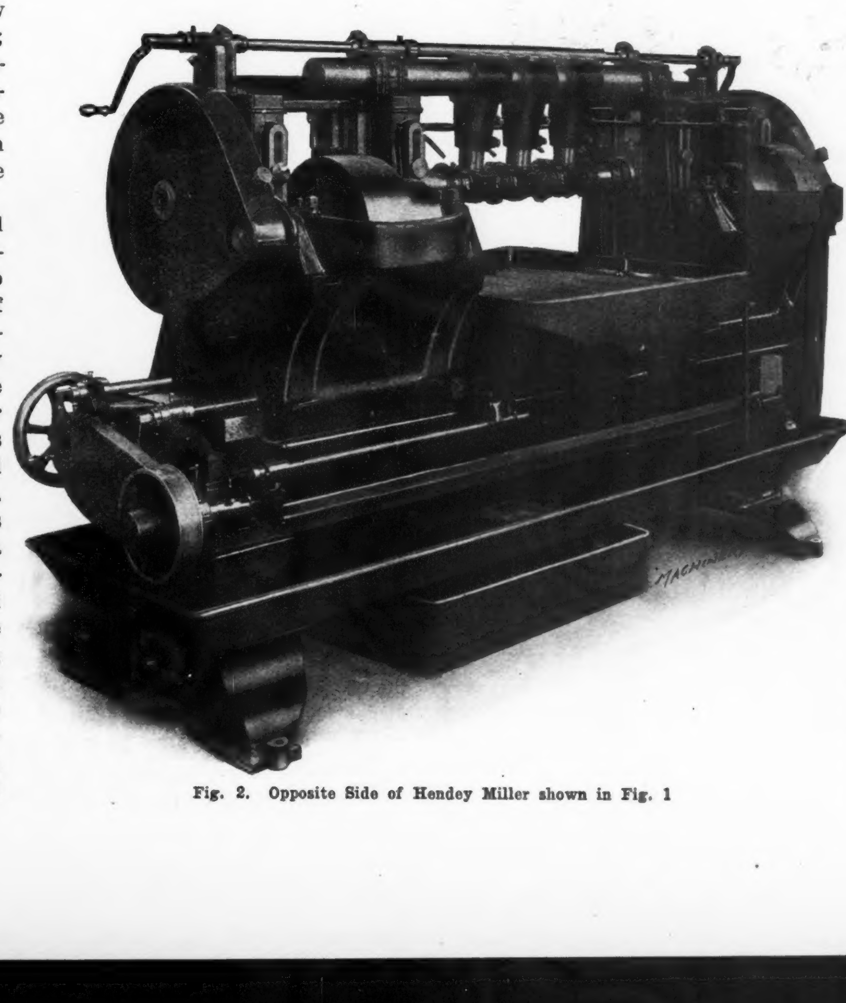


Fig. 2. Opposite Side of Hendey Miller shown in Fig. 1

ants being fitted with split bearings which are hinged so that the bottom half falls away to facilitate quick removal of the arbor. The table is fitted with power quick return and is geared for a speed of approximately 100 inches per minute. High sides are provided on the table for confining the cutting lubricant. The machine is made with different lengths of bed and furnished with tables of different working dimensions. It is equipped either with or without an oil pan, pump and piping, according to the requirements of different users.

ANDERSON ROLLED GEARS

In the November, 1910, number of MACHINERY, a description was published of a machine developed by H. N. Anderson, chief engineer of the Speedwell Motor Car Co., Dayton, Ohio, for the purpose of producing gears by a method styled the "molding-generating process." By this method the gear blank is heated to a forging temperature and rolled in

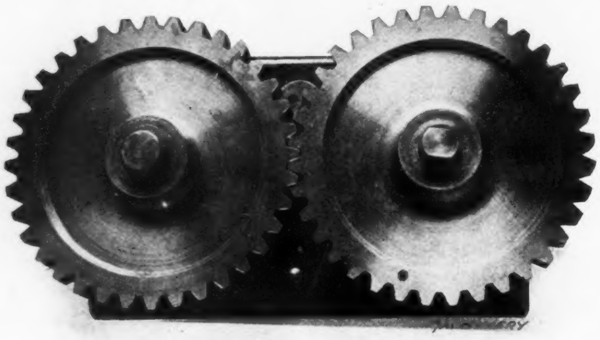


Fig. 1. Spur Gears rolled by the Anderson Process

contact with a roller in which accurate gear teeth of the required size have been cut. This results in forming the teeth in the gear blank. At the time the article referred to was published, gears were being produced by this method on a commercial basis, but the results obtained were somewhat crude. The metal displaced in rolling the teeth in the gear

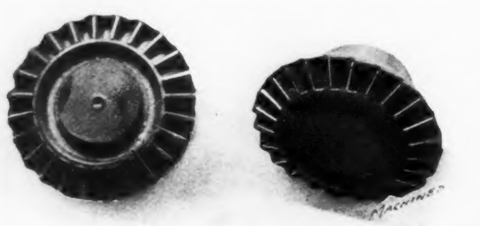


Fig. 2. Bevel Gears rolled by the Anderson Process

blank was forced out to the sides of the blank, thus leaving an irregular surface from which it was necessary to trim the flash.

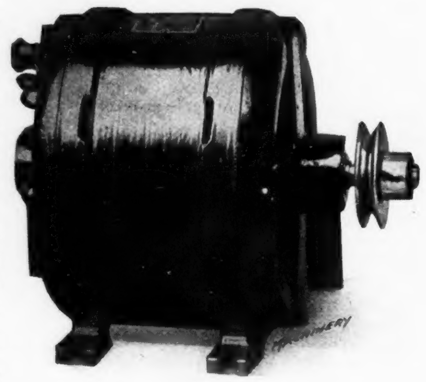
This method of producing gears has been steadily improving and the Anderson Rolled Gear Co., Cleveland, Ohio, has now been formed for the purpose of manufacturing gears by this method. As produced at the present time, the metal displaced in rolling the gear teeth is prevented from flowing

Fig. 3. Herringbone Gears rolled by the Anderson Process

out at the sides of the gear. The result of rolling the teeth in gears, under these conditions, is that the metal is compressed and its strength is said to be considerably increased. The accompanying illustrations show examples of spur, bevel and herringbone gears produced by this process, from which an idea can be gathered of the excellence of the work that is secured. The Anderson Rolled Gear Co. is prepared to take orders for gears produced by this method, but the company does not intend to build gear-rolling machines for the market.

SELF-STARTING ALTERNATING-CURRENT MOTORS

The distinctive feature of a line of small self-starting, alternating-current motors which has been placed on the market by the Electric Specialty Co., Stamford, Conn., consists of the elimination of the usual starting clutch, owing to the inherent difficulties arising from its use. A special split-phase winding has been used which gives a starting torque and overload capacity of 175 per cent of the full load rating. In designing these motors, special attention has been given to the elimination of all magnetic "hum," making them especially adapted for use on musical instruments and for driving office and household fixtures where such a noise is objectionable. Particular care has also been given to the prevention of temperature rise which does not exceed 30 degrees C. These motors are built in sizes ranging from one-tenth to one-third horsepower. They are equipped with under-feed wick oil-cups, the oil being fed through special ¼-inch wicks. The same general type of motor is also built in sizes ranging from one-sixth to one-half horsepower and equipped with oil-ring bearings.



Electric Specialty Co.'s Self-starting Alternating-current Motor

DRIVER TOOL RACK

In addition to the sectional drill rack which automatically gages drills when put into it, that was illustrated and described in the September, 1911, number of MACHINERY, C. H. Driver, 1419 Sixteenth St., Racine, Wis., is now making a

Driver Sectional Tool Rack for Steel Bits and Holders

sectional tool rack for holding steel bits and the holders for them. This rack is also adapted for holding all sizes of forged tools. The sectional feature affords an arrangement by which racks can be made to hold any desired shapes or sizes of tools and holders. Each section of the rack is made in such a way that it will only hold the size of tools for which

it is intended; tools that are larger than the size for which the section is made cannot be put into that section, while smaller tools will fall through. In this way, the rack automatically arranges the tools according to size when they are put into it. By putting the tools in the rack with the cutting ends up, the required shape and size of tool can be picked out at once. These racks can be stood on tool boards, secured to a side wall or post, or set in any position on the machine on which the tools held in the rack are to be used. The use of these racks is the means of saving time lost in hunting through a miscellaneous collection of tools in a box, in order to find the tool required for handling a given job.

LIBBY COMBINATION BAR AND CHUCKING TURRET LATHE

The application of a collet chuck which the International Machine Tool Co., Indianapolis, Ind., has recently introduced on the Libby heavy turret lathe, meets the demand which has existed in the turret lathe field for a combination bar and chucking machine. With this equipment, the machine can be transformed from a complete chucking machine into a complete bar machine or *vice versa*, in a few minutes' time

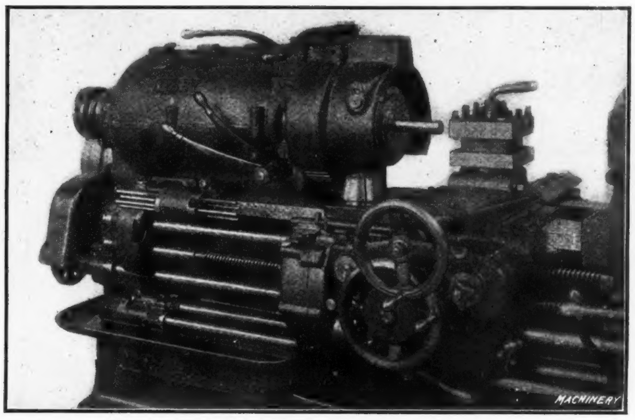


Fig. 1. Libby Turret Lathe with the New Collet Chuck in Position

and without requiring any alteration of the machine except changing the chuck and tools in the turret. Figs. 1, 2 and 3 illustrate the Libby lathe with different equipments. In Fig. 1 an 18-inch Libby turret lathe is shown with the new heavy-duty collet chuck mounted in position, ready for handling bar work. Fig. 2 shows the same machine 15 minutes later with the collet chuck housing and body removed. Fig. 3 shows the same machine five minutes later with the standard four-jaw combination chuck mounted in position for handling chucking work. The time required to change the machines over for handling chucking work or bar

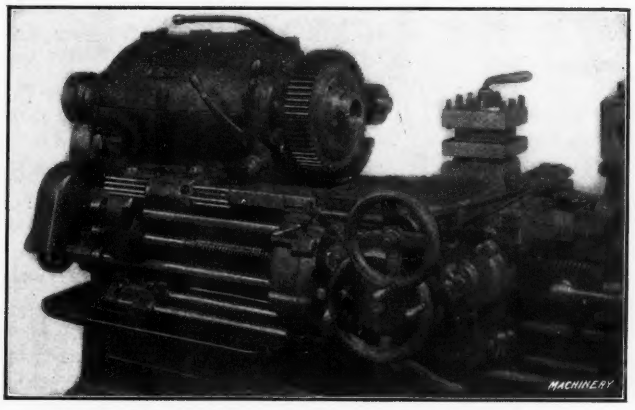


Fig. 2. Machine shown in Fig. 1 (Fifteen Minutes Later) with Collet Chuck removed

work is less than twenty minutes. The entire headstock, including the main driving gear, remains undisturbed as well as every operative part of the machine.

The new collet chuck is a self-contained unit. The housing which carries the lever control and the fork is bolted to a pad on the machine headstock housing at a point over the front spindle bearing. By removing four bolts, the collet chuck housing can be quickly removed. The collet chuck body screws onto the threaded nose of the machine spindle and like the housing, can be quickly removed as a single unit. The taper seat on the spindle locates the collet chuck or the standard chuck firmly and accurately in place. The collets

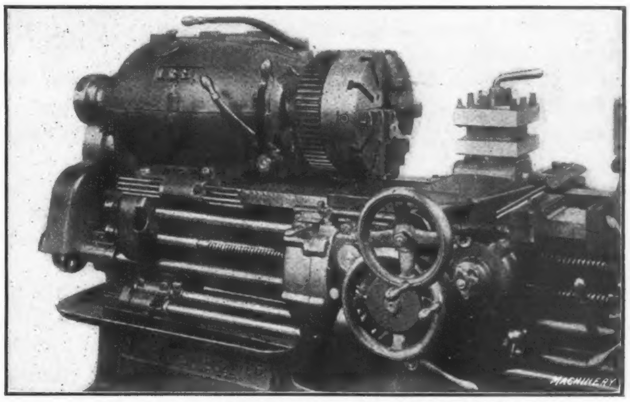


Fig. 3. Same Machine (Five Minutes Later) with Four-jaw Chuck in Position

have a parallel powerful grip on the stock and are so arranged that they retain their approximate position when there is no stock in the chuck. The collets are in four segments and each set is arranged for one-eighth inch variation in the diameter of the stock. The chuck has a capacity for bars from 3/4 to 3 inches in diameter and collets can be furnished in one-eighth inch intervals for this complete range. Collets can be furnished for holding either round, square or hexagonal stock. All sliding or wearing parts are of hardened steel and the control lever for operating the collets is conveniently located at a point close to the speed changing levers on the headstock.

TOWNSEND TAPER TURNING ATTACHMENT

The cast-iron base of the Townsend taper turning attachment is intended to take the place of the regular toolpost, and

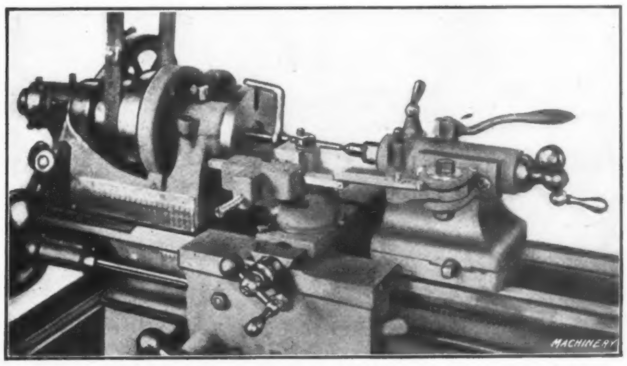


Fig. 1. Townsend Taper Turning Attachment set up on a Lathe

washers are provided which enable the operator to set the tool at various heights in order to bring it to the center of the work. The base carries a sliding tool-holder which is adapted for using standard 5/16-inch square tool bits. The tool-holder is provided with a hardened steel follower shoe which bears against a templet that guides the tool in forming the work; this templet is anchored against longitudinal movement by means of a bracket secured to the tailstock by

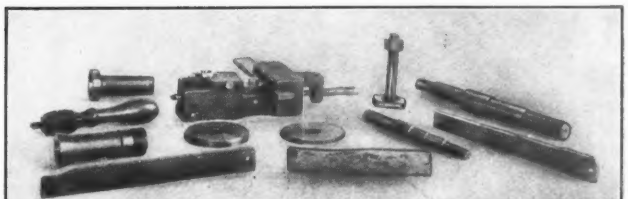


Fig. 2. Taper Turning Tool and Templets used in machining Different Classes of Work

two screws. The arm of the bracket is held by a clamp bolt and can be swung to any position required to bring the stud which holds the connecting link in line with the templet, thus preventing all tendency toward cramping.

The tool may be set up and adjusted almost as quickly as an ordinary lathe tool and is handled in exactly the same way. The carriage of the lathe is free to be moved to any position, and as the cross-slide may be moved in and out to bring the tool to or from the work, it will be evident that the use of the tool is not at all complicated. The follower shoe on the sliding tool-holder is held against the templet by means of a coiled spring and will follow any form of templet desired. The split collet shown at the left in Fig. 2, has its templet in front of it, and the spindle at the extreme right is shown with a templet which was used for turning shoulders. It will be readily seen that this tool possesses great advantages and that the only measuring required is to get the diameter at the end of the work, and the length and the position of the shoulders, all other dimensions being taken care of by the templet without requiring further measurements to be made. The pieces produced are exact duplicates. As a result, an ordinary engine lathe can be made equal to a screw machine for use in interchangeable manufacture. In turning tapers in the tool-room, the attachment is especially valuable, as the tailstock does not have to be moved and no setting of the taper attachment is required. The proper taper is secured without resorting to cut-and-try methods. Individual brackets may be used on several lathes or a bracket may be used which is attached to the lathe bed back of the tailstock. Where one of these tools is available, every lathe in the shop can be equipped with a taper attachment inside of five minutes. The H. P. Townsend Mfg. Co., Hartford, Conn., is the manufacturer of this equipment.

WILMARTH & MORMAN UNIVERSAL CUTTER, REAMER AND TOOL GRINDER

For several years, the Wilmarth & Morman Co., 1180 Monroe Ave., Grand Rapids, Mich., has been building an inexpensive type of combination cutter, reamer and drill grinder. As the

Fig. 1. Grinding Work on Centers in the Wilmarth & Morman Universal Grinder

company is already prepared to meet the demand for a machine of this kind, the new universal cutter, reamer and tool grinder, which forms the subject of the present article, has been designed along different lines. No expense has been spared to make the machine absolutely universal, to have its range adequate for the requirements of all classes of work for which it is intended, and to construct it along lines which provide adequate strength and durability.

The base of the machine is 24 by 24 inches in size and provides a rigid support. The inner column is bolted to the base and carefully ground to provide a perfect bearing surface for the outer sleeve. Particular attention has been paid to the provision of means for preventing dirt or grit from finding its way into the bearing between the sleeve and column, so that there is no danger of damage from this

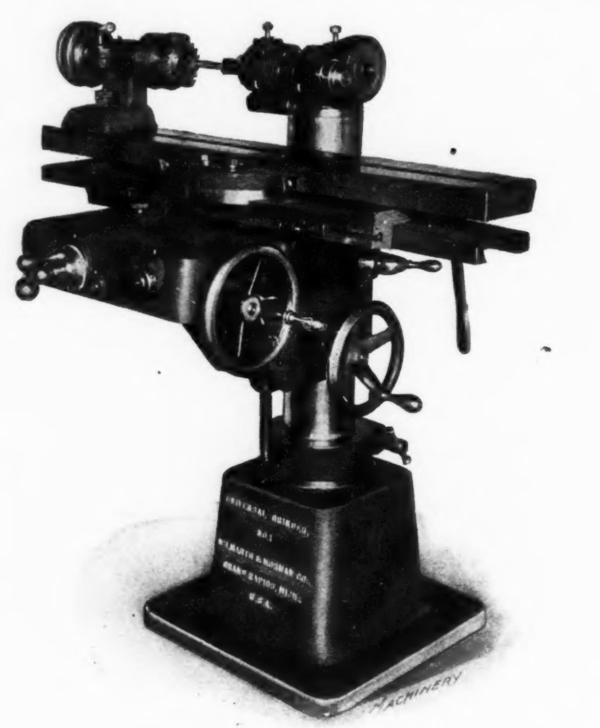


Fig. 2. Grinding the Hole in a Milling Cutter

source. The wheel-head is bolted to the top of the column and the sleeve rotates around the column, its bearing being a tight fit so that there is absolutely no room for shake or play. After the sleeve has been rotated to the required position, it is clamped to the column by means of wedges which are drawn together by a clamping screw located near the base of the sleeve. These wedges are shaped in such a way that they fit the curvature of the base of the column. There is no tendency for the wedges to score the column but they provide an absolutely rigid lock. Reference to the illustrations will show that the sleeve is not slotted to provide this clamping action; as a result, the sleeve remains perfectly round at all times. A graduated dial at the top of the base indicates the setting of the table in relation to the grinding wheel spindle.

The outer sleeve which provides the bearing for the knee is 6 inches in diameter; it is ground to provide an accurate bearing for the knee. Instead of having a bearing on V-ways, the knee has a bearing around the circumference of this sleeve which amounts to almost nineteen lineal inches. To insure having the knee move in an absolutely perpendicular line, a large key is mounted at the back of the sleeve. While there is very little possibility for wear to develop at this point, suitable means of adjustment is provided so that the knee may always be kept a tight fit on the key. The knee is not slotted to provide a clamping action on the sleeve, and as a result a perfect bearing on the sleeve is retained at all times. The knee is raised and lowered by means of the lower handwheel. Graduations are provided for making accurate settings.

The saddle is fitted to the top of the knee with an ample bearing, and means are provided which enable any wear which may develop to be taken up. The table bearing is 28 inches in length and provision is also made for taking up any wear which may develop in the table slide, a tapered gib which runs the full length of the bearing being provided for this purpose. A sub-table and the table are carried on the

saddle. The table is carried on a circular bearing with auxiliary supports near the end. In this way any weight—even at the very end of the table—is rigidly supported, and there is no tendency to spring or deflect the table in any way. The circular table bearing is of generous proportions and graduated in degrees for convenience in setting for grinding tapers. In addition, a fine adjustment may be obtained by means of two knurl-headed screws at the front of the table, which provide for getting that small fraction of a degree that may be necessary in setting up a piece of work. This can be done without unlocking the bolts which provide the primary clamp. The table is provided with a single T-slot at its center and means are furnished for locating the centers absolutely in line by the same operation which clamps them to the table. Either a center, a chuck or a face-plate may be used interchangeably in the headstock.

The internal grinding attachment provides for grinding holes 3 inches in depth for diameters ranging from ½ inch up to 1¼ inch, while holes from 1¼ inch in diameter up can be ground to a depth of 5 inches. The vise is provided with both angular adjustments and a swivel base, so that even compound angles can be conveniently ground. In designing this machine, particular attention has been paid to the provision of convenient methods of handling. When engaged on surface grinding, cylindrical grinding or internal grinding, a very smooth even action of the longitudinal movement of the table is required. This work is usually handled from the front of the machine, from which point a clear view of the action of the wheel is readily obtained. When operated from the front, the longitudinal movement of the table is provided by the upper handwheel at the right-hand side, which imparts the longitudinal movement to the table by means of a worm-gear. The cross-feed movement is provided by means of a ball-crank handle at the front of the saddle and the vertical movement by means of the lower handwheel at the right-hand side. The control of all of these movements is within easy reach of the operator without requiring him to move from his position at the front of the machine, and scarcely requiring him to stoop. For grinding the teeth of milling cutters, the slow even movement of the

Fig. 3. Grinding a Forged Tool held in the Vise

table is not required. For such work, in order to observe the cutting action of the wheel, the operator takes a position at the back of the machine, and when operating from this position the lever movement for providing the longitudinal travel of the table is utilized. The cross-feed is obtained by the ball-crank handle leading out from one side of the saddle at the rear. The wheel for the vertical movement of the saddle is within easy reach of the operator from this point without requiring him to move. It will be clear from this description that the machine can be completely controlled from either side without the operator having to change his position. It should be mentioned at this point that the worm-operated handwheel is thrown out of mesh when the lever movement is engaged.

Fig. 4. Grinding a Face Milling Cutter

The capacity of the machine is as follows: The longitudinal movement of the table, 22 inches; cross movement of the table, 8 inches; vertical movement of the knee, 11 inches; swing, 10 inches; maximum capacity between centers, 30 inches; working surface of table, 5½ by 42 inches; universal attachment swings 16 inches over the table and 24 inches over the sub-table; opening of vise, 2⅜ inches; net weight of machine with attachments, approximately 1200 pounds.

NEW MACHINERY AND TOOLS NOTES

Electric Crane Controller: Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. A line of magnet-switch crane controllers which includes equipments adapted for single trolley, bridge or hoist motors, or for a combination of motors in series or parallel.

Arc Welding Machine: C. & C. Electric & Mfg. Co., Garwood, N. J. A machine adapted for handling welding and repair work in shipyards, machine and locomotive shops and foundries. The entire equipment is mounted on a truck to adapt it for portable service, and it is claimed that this portable machine possesses all of the features of the larger stationary equipment.

Chain Draw Benches: Brightman Mfg. Co., Columbus, Ohio. A chain draw bench which is said to be the largest equipment of its kind that has ever been built. It is adapted for drawing all sizes of rounds from 1 to 6 inches in diameter and irregular shapes having the same area. A push-in attachment is provided for pushing the bars through the die ready to be gripped by the drawing carriage.

Multiple-spindle Drill: Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. This machine is of new design and is the largest of a line of four multiple-spindle drills which has been brought out by the Baush Machine Tool Co. The main drive is through a pair of spiral gears, the pinion being of hardened steel and the wheel of hard bronze; these gears run in oil. The head is accurately counterweighted and supported by means of two cables, and a safety locking device is provided so that if either or both cables fail, the head will be locked to the base. Four changes of feed are provided, two changes being obtained by means of a cone pulley and two by gearing controlled by a jaw clutch.

THE SCHOOP METAL SPRAYING PROCESS

A LATELY DEVELOPED METHOD FOR APPLYING A METAL COATING TO A GREAT VARIETY OF SURFACES

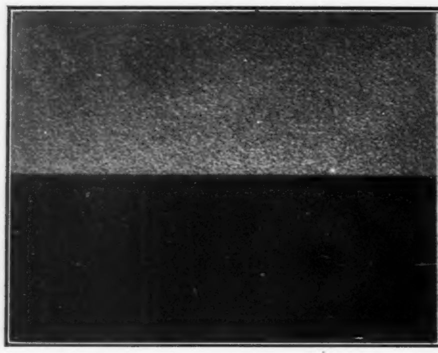


Fig. 1. Surface sprayed with Copper shown at Top, and Similar Surface after polishing shown at Bottom

Fig. 2. Surface sprayed with Brass shown at Top, Aluminum in the Center, and Copper Below

Fig. 3. Illustration showing how Thick Layers of the Coating may be applied by the Spraying Process

ONE of the most radical of recent developments in metal-working methods is the new Schoop metal-spraying process, which is now being placed in the hands of the public. Briefly, the process consists in reducing metallic wire to impalpable dust by means of an oxy-hydrogen flame and then forcing these metallic particles with great velocity against the surface of the object to be coated. The particles then embed themselves in the surface of the piece to be plated and homogeneously unite with the succeeding particles that are projected upon them. The result is an even coating of deposited metal, adhering to the coated object. The deposited metal is amorphous and not crystalline in its structure, and more dense than the wire from which it came. The spraying is done by the special torch or pistol shown in Fig. 4, the wire being fed into the pistol from one side and emerging at the torch end in a fine spray. Figs. 1, 2 and 3 show coatings applied by the process.

Origin of the Process

The Schoop process was the result of observations made while shooting with a rifle, the inventor noticing that when the leaden bullet struck a stone or piece of cement the lead was driven into the pores of the stone, literally rooting its way in. Moreover, when a bullet struck another previously fired bullet, the two pieces of lead were homogeneously united. Mr. Schoop, who is a native of Zurich, Switzerland, first tried the use of a tank of molten metal, from which drops were atomized and then forced out with compressed air. This had the defect of being too cumbersome an apparatus and, what was more important, the hot metal rapidly oxidized, especially when in contact with the air blast. Later, metal was reduced to dust by grinding, and this dust projected as before. This method was more successful, but the expense of metallic dust and the rapid oxidization made it impracticable. The final development of the process is the one here described. The apparatus weighs but 3½ pounds, and hence is not cumbersome; oxidization is prevented by the hydrogen gas with which the metallic particles are surrounded while being projected.

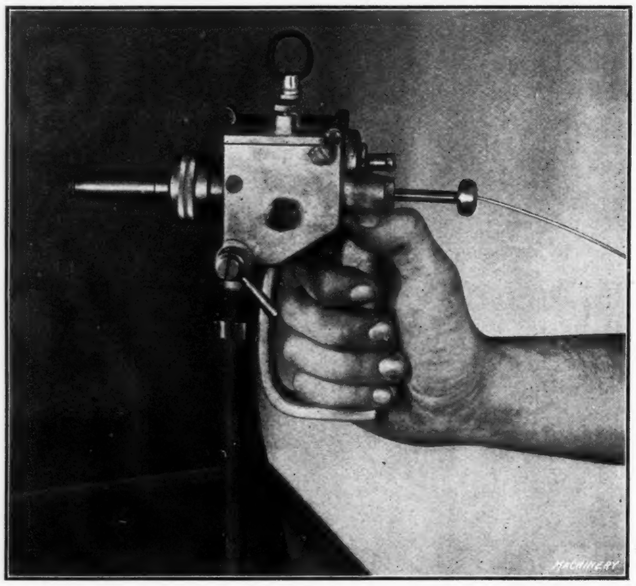


Fig. 4. Spraying Pistol used in the Schoop Metal Coating Process

By means of this remarkable process, it is possible to coat metal, wood, paper, cloth, stone, cement and other substances with lead, tin, zinc, aluminum, copper, brass, bronze, German silver, gold and even steel. It is the only known method of plating with aluminum and steel.

Details of the Process

The mechanism within the pistol serves the purpose of feeding the wire into the nozzle of the torch as indicated in Fig. 5, which best illustrates the action of the process. The nozzle consists of three tubular parts; the inner part that acts as a guide for the wire; the middle section which, in connection with the inside part, forms a conducting tube for the oxy-hydrogen gas; and the outer part, or nozzle proper, which forms a protecting case, and which, in connection with the middle section, forms a tube through which the compressed air is led to the projecting point. The metal wire is fed forward just fast enough to allow it to be disintegrated by the flame and carried to the work by the air blast, the metallic dust being held in suspension in the expanding gas, and carried forward by the air pressure. The wire used is from 0.030 to 0.040 inch diameter and is fed forward at a speed of from ten to eighteen feet per minute—the metals that melt at high temperatures being fed the slowest to allow the flame more time for disintegration.

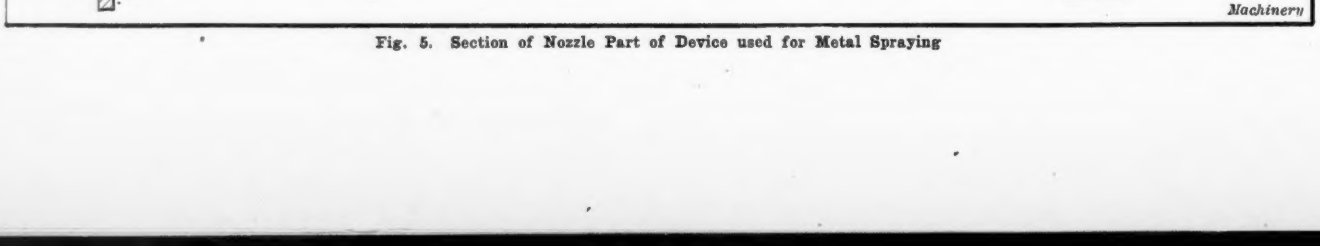


Fig. 5. Section of Nozzle Part of Device used for Metal Spraying

The oxygen and hydrogen may be supplied from standard commercial tanks, but when the process is worked on a large scale, it is advisable to make the gas on the premises for the sake of economy. The tank pressure of the oxygen is 120 atmospheres and of the hydrogen 20 atmospheres, but the oxygen and hydrogen are both used at a pressure of 30 pounds to the square inch. The compressed air is of 100 pounds pressure and is used at the rate of 35 cubic feet per minute. It is important that the proportions of oxygen, hydrogen and air be adjusted for each of the metals used, and that the wire feed be of the right speed in proportion to the flame.

Theory of the Disintegrating and Coating Action

One of the most singular facts relative to this process is that the metal is not applied in a molten state. The correct operating distance is from five to six inches from the pistol point to the work. At this distance a piece of paper or even a match may be coated without danger of ignition. The spray may be directed at the hand without injury. The reason for this is that the gaseous medium is so much larger in volume than the drop of metal reduced to a powder, that the expanding gas cools the metallic spray before it strikes the surface to be coated. The heat of collision, however, causes the particles to vaporize and condense on the relatively cold surface and thus form a homogeneous coating. In addition to the union of the projected particles themselves, the first ones to strike the surface are driven into the pores of it.

The surface produced by this process is granular in appearance; it resembles a sand-blasted surface and on this account does not lend itself readily to polishing, and the process is not recommended where a high finish must be obtained. By proper treatment in the polishing room, however, a well finished surface can be secured. There is no tendency toward peeling or flaking when polishing.

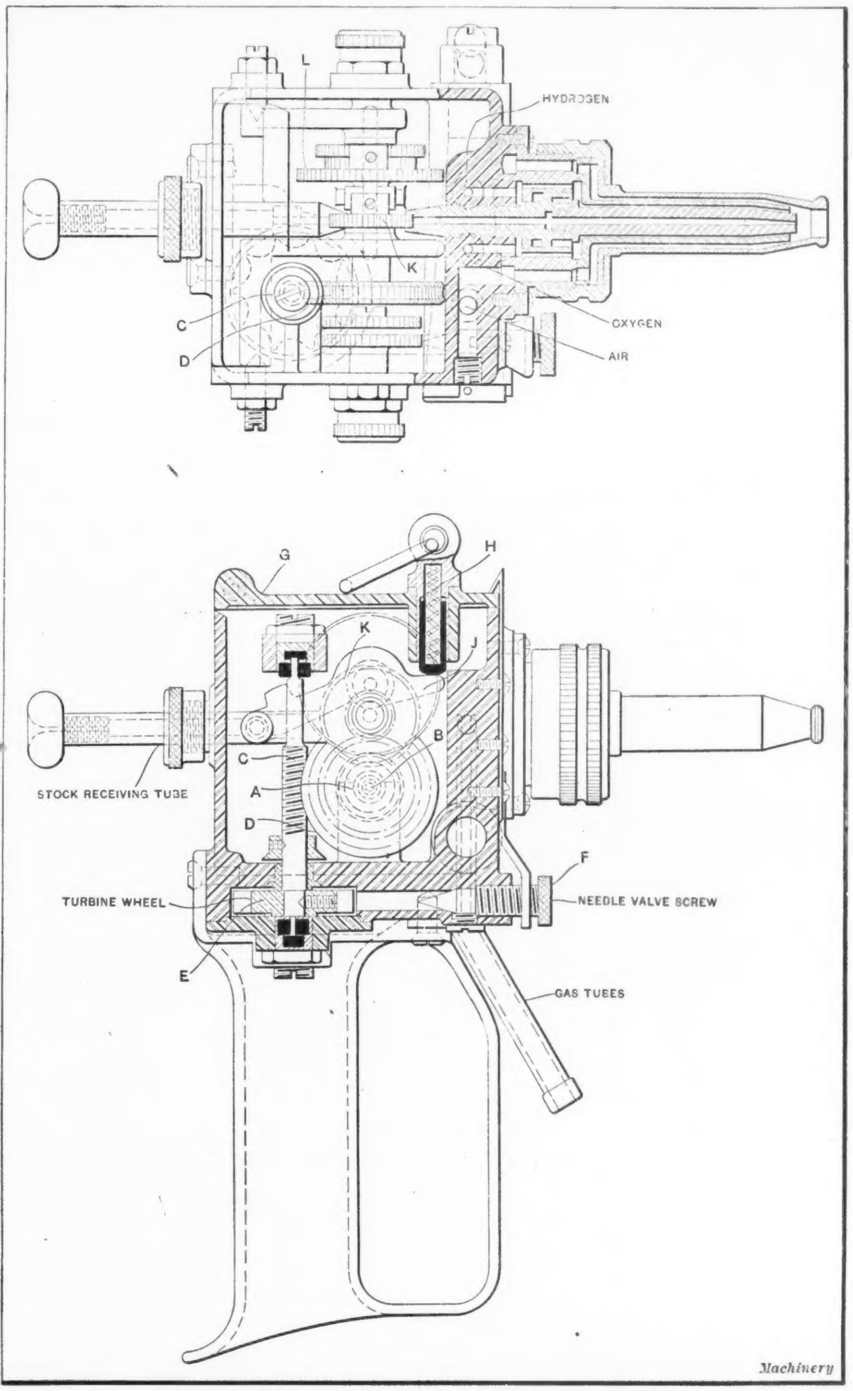


Fig. 6. Section showing Design of Metal Spraying Pistol

The Spraying Mechanism

The spraying pistol is shown complete in Fig. 4, but Fig. 6 will enable the reader to understand its operation better. It has but two functions to perform—the leading of the air and gases to the spraying point and the feeding of the wire. The gas tubes, one for oxygen and one for hydrogen, and the air tube, are placed side by side (see Fig. 6), having proper connection with the concentric tubes in the nozzle.

The wire feed is operated by an air-driven turbine. Entering the pistol box through the stock receiving tube, the wire passes to a pair of toothed feed-wheels that propel it straight forward to the nozzle. The lower feed-wheel *A* is mounted on the main shaft *B*. This shaft is driven by a worm and worm-wheel *C* and *D*. The worm-shaft has at its lower end a turbine wheel *E* mounted in ball bearings. This wheel is driven by air from the main supply tube and its speed, and consequently that of the wire feed, is governed by the amount of air that enters through needle valve *F*. A shut-off valve cuts off the air completely when the pistol is not in operation. This valve, as well as some of the internal parts, can best be seen in Fig. 7, which shows the pistol with the cover raised. The cover is shown at *G* in Fig. 6. It is provided with two spring plungers *H;* when the lid is down, these plungers bear against bracket *J* that carries the upper feed-wheel *K* and the driving gear *L*. Opening the lid for inspection, releases pressure on bracket *J* and prevents the wire from feeding. Beside gear *L* are two other gears used with corresponding pinions for speed changes. These comprise the principal parts of the pistol.

Operating the Pisto

Figs. 8 and 9 give a good idea of the operation of the process. Fig. 8 shows how the operator directs the spray onto the work, holding it within an enclosure provided with a suction draft to take away loose particles. On the right may be be seen the oxygen and hydrogen tanks. Fig. 9 shows the operation in detail, illustrating the gripping of the torch, and the length cf the flame. In Fig. 8, the operator is coating a wooden pattern for molding. When metal is to be coated, it must first be cleaned of all grease or dirt before spraying. The sand-blast gives the best results, as the rough finish helps the sprayed coating to adhere.

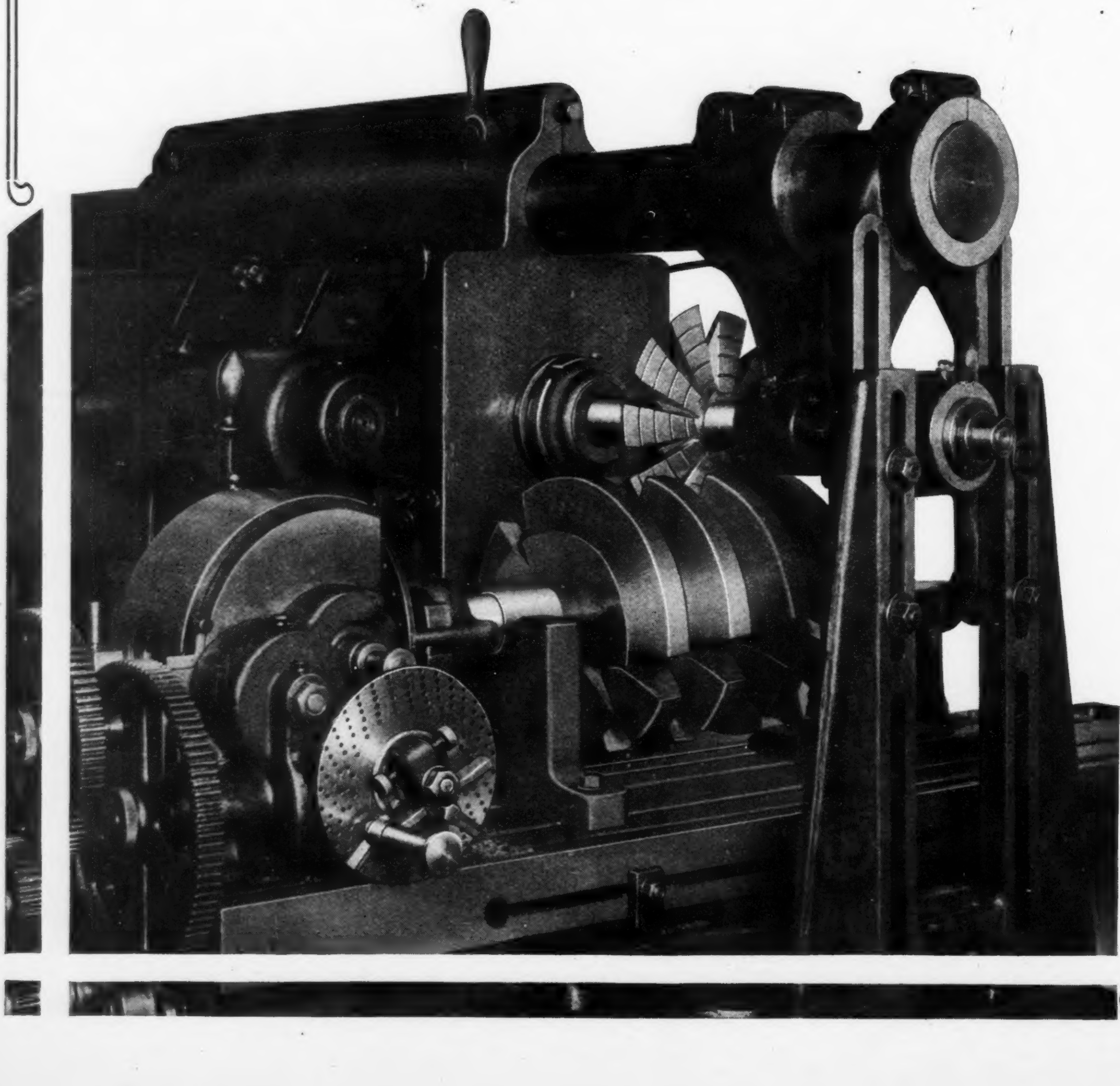
It is interesting to note some of the phenomena of the Schoop process as shown in Figs. 2 and 3. Fig. 2 shows the application of three adjoining coatings of brass, aluminum and copper. Ordinarily, the coating applied for decorative or protective purposes is about 0.001 inch thick, but if required, the coating may be made one-sixteenth inch thick or

Gashing a Big Hob

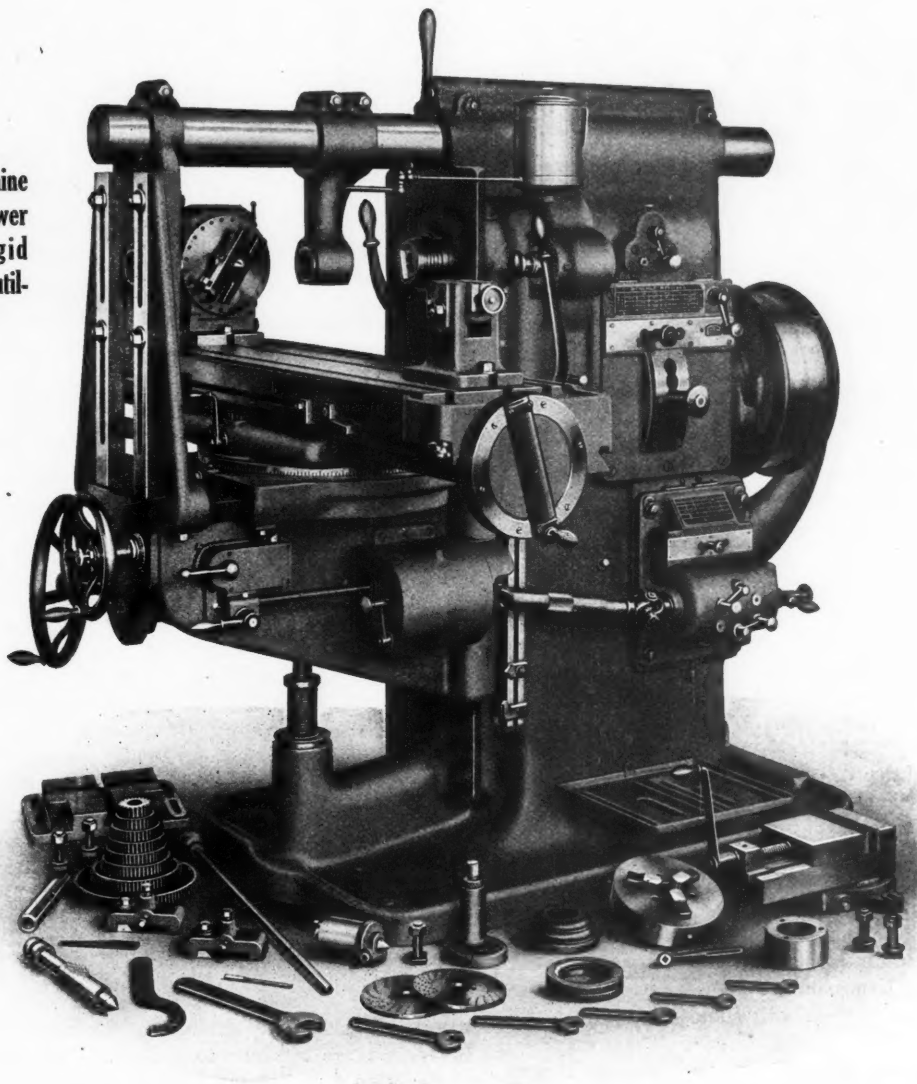
A type of toolroom milling calling for Rigid construction and fine feeds.

This is not an everyday job, but it represents a class of work that is constantly coming up in shops handling large work. This hob of special grade high-speed steel is 11″ in diameter by 12″ long and weighs about 300 pounds after gashing. The 10″ diameter cutter is taking a V cut 2″ wide at the top and 3″ deep.

In order not to break off the ends of the cutter teeth, owing to their length and thinness, a feed of only .0059″ per revolution can be used. Our heavy Universal Milling Machines with constant speed drive have a series of very fine feeds for such work driven from the spindle, **in addition to** the broad range in revolutions per minute driven from the constant speed shaft. They are machines with a capacity for the unexpected jobs.



A Milling Machine of big pulling power with parts rigid enough to fully utilize this power.



No. 3A Heavy Universal Milling Machine

This is the machine which handled the job shown opposite. It is a rugged representative of our line of Constant Speed Drive Universal Milling Machines, all of which are adapted to rapid, accurate work in the toolroom or shop floor of heavy machinery and engine builders, railroad shops, etc. A well braced one-piece frame, with a massive knee, connected to it by stiff arm braces makes for steadiness under the heaviest cuts. Ask us for literature descriptive of its features.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I.

OFFICES: 20 Vesey St., New York, N. Y.; 654 The Bourse, Philadelphia, Pa.; 626-630 Washington Blvd., Chicago, Ill.; 305 Chamber of Commerce Bldg., Rochester, N. Y.; Room 419 University Block, Syracuse, N. Y. **REPRESENTATIVES:** Baird Machinery Co., Pittsburgh, Pa., Erie, Pa.; Carey Machinery & Supply Co., Baltimore, Md.; E. A. Kinsey Co., Cincinnati, O., Indianapolis. Ind.; Pacific Tool & Supply Co., San Francisco, Cal.; Strong, Carlisle & Hammond Co., Cleveland, O., Detroit, Mich.; Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; Perine Machinery Co., Seattle, Wash.; Portland Machinery Co., Portland, Ore. **CANADIAN:** The Canadian Fairbanks-Morse Co., Ltd., Montreal, Toronto, Ottawa, Winnipeg, Calgary, Vancouver, St. Johns. **FOREIGN:** Buck & Hickman, Ltd., London, Birmingham, Manchester, Sheffield, Glasgow. F. G. Kretschmer & Co., Frankfurt, a/M., Germany. V. Lowener, Copenhagen, Denmark; Stockholm, Sweden; Christiania, Norway. Schuchardt & Schutte, St. Petersburg, Russia. Fenwick Freres & Co., Paris, France; Liege, Belgium; Turin, Italy; Zurich, Switzerland; Barcelona, Spain. The F. W. Horne Co., Tokio, Japan. L. A. Vail, Melbourne, Australia. F. L. Strong, Manila, P. I.

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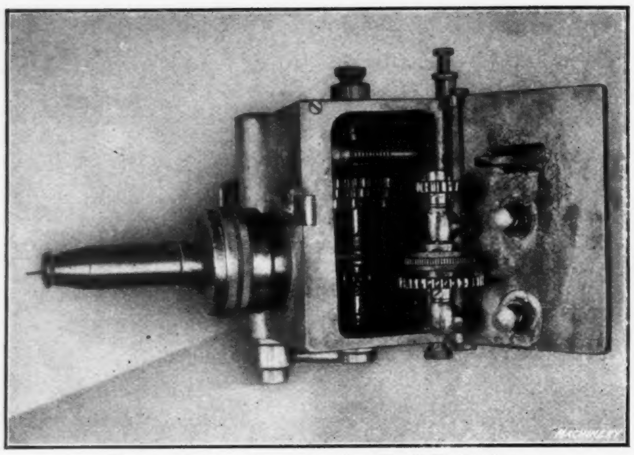

Fig. 7. Device Open, showing Feed Mechanism

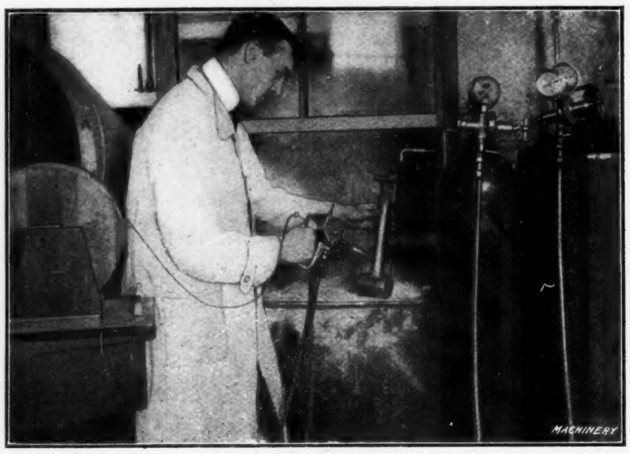

Fig. 8. Application of Pistol for coating a Wooden Pattern with Metal

more. Fig. 3 shows at the left a thick spot of spraying. The top of this spot has been filed to show the density of the structure. At the right a "mountain" of metal has been applied and the flame purposely held close to show how, under such conditions, the surface is melted and discolored. If, on the other hand, the flame is held at a greater distance than six inches, only a few of the metal particles adhere, the rest, because of loss of velocity, being lost before reaching the plate.

Applications of the Process

The applications of the process are many. In general, these may be classed under three main heads: first, protective coatings; second, decorative coatings; third, detachable coatings. Under the head of protective coatings comes rust-proofing with zinc and lead; covering of wooden patterns; covering wooden work that is to be exposed to the weather; and covering parts of metal to prevent cementation when carbonizing. It is not necessary to take large work to the apparatus, as is required in electro-plating. The wooden shingles on a roof can be just as well covered as a small metal pin. Moreover, the coating can be more evenly applied on large objects than is possible when electro-plating, but at the same time, it is possible to give an article a heavy application at points where wear will come, as, for instance, on piano pedals.

For decorative purposes, the field is even larger. Plaster statues may be bronze-coated at the cost of a few cents. Wooden carvings can be coated to resemble hand-chased metal work; aluminum can be applied to any object, and as many different metals as desired may be applied to the same piece. The vase in Fig. 10 is a good example of decorative coating. For copying medals and making electrotypes, the field is large. Steel-faced cuts may be made by coating the mold with oil and then spraying. Many other uses in the printing trades will be developed.

In Fig. 10 may also be seen an egg coated with lead; a piece of glass coated with aluminum; a name-plate coated with brass, having the faces of the letters polished; and several miscellaneous coated parts. Glass may be readily plated by first sand-blasting, and paper and fabric of all kinds may be metal coated and still retain flexibility. Recently a manufacturer had some printing press cylinders, the surfaces of which were porous. Ordinarily, these castings could not have been used, but by spraying them with brass, and then turning the cylindrical surface once more, they were made literally "better than new."

Cost of Spraying Metal

An operator can apply metal to objects at the average rate of one square foot per minute. On soft metals the coat can be applied at twice that speed and with steel or nickel the time would be longer. A pound of lead can be sprayed in less than a minute. The total cost of spraying with soft metals, coating the work about 0.001 inch thick, is less than two cents per square foot. This includes metal, labor and gases at "small-quantity" prices.

The Metals Coating Co. of America, People's Gas Building, Chicago, Ill., controls the rights of this process in the United States; this concern issues licenses for the use of the process and leases the spraying pistols. C. L. L.

* * *

The Panama Canal was formally opened to commerce Saturday, August 15. On that day the Panama Railroad steamer *Ancon* passed through the canal from Cristobal, on the Atlantic side, to Balboa, on the Pacific coast. This was the first large steamer to make the trip through the canal. She carried four hundred guests, including Governor Goethals and President Torras of the Panama Republic. The canal is now open for all commercial vessels having a tonnage not exceeding 10,000 tons. The trial trip was very successful, the locks being operated rapidly and with accuracy.

* * *

MACHINERY will be represented at the Foundry & Machine Exhibition in the International Amphitheater, Chicago, Ill., September 5-11. An exhibit of MACHINERY'S Handbook, reference books, gear books, copies of MACHINERY and field service advertising photographs will be shown in booth 215, on the west side of Machinery Hall. A hearty invitation to visit the booth and become acquainted is extended to all visiting the exhibition.

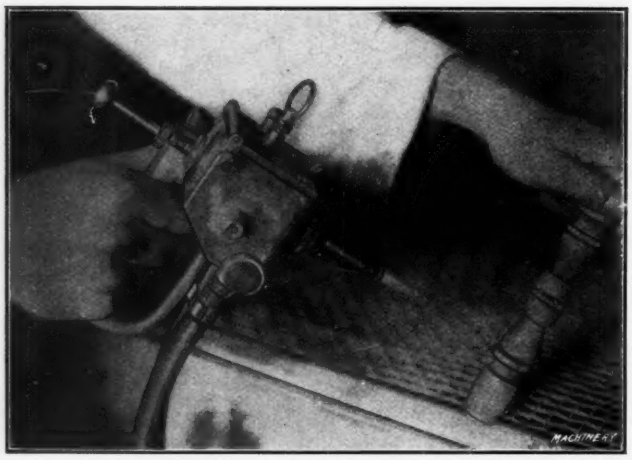

Fig. 9. Method of holding Device when coating

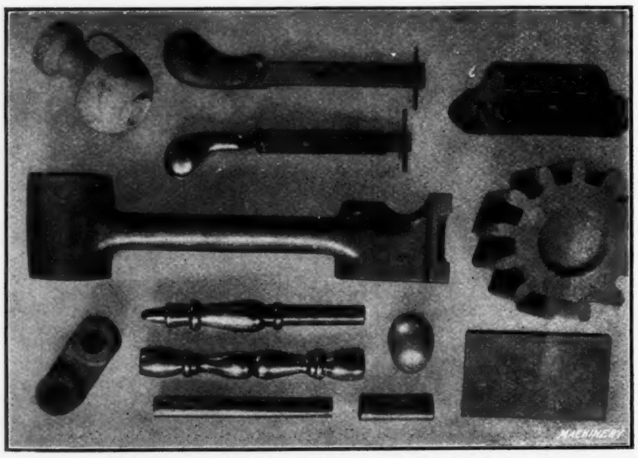

Fig. 10. A Number of Objects coated by the Metal Spraying Process

PERSONALS

E. St. Elmo Lewis, for ten years advertising manager of the Burroughs Adding Machine Co., Detroit, Mich., has been made vice-president and general manager of the Art Metal Construction Co., Jamestown, N. Y.

L. E. Honeywell has been made advertising manager of the National-Acme Mfg. Co., Cleveland, Ohio, succeeding Paul E. Ryan, resigned. The assistant foreign sales work of the company has been assumed by A. E. Henn, assisting W. S. Chase as general sales manager.

W. K. Millholland, Jr., formerly chief designer with the Warner & Swasey Co., and more recently in charge of the Cleveland sales office of Potter & Johnston Machine Co., Pawtucket, R. I., is bringing out the Millholland lathe at the plant of the Greaves-Klusman Tool Co., Cincinnati, Ohio.

W. L. Rickard, of Rickard & Sloan, Inc., 20 Vesey St., New York City, will make an extended trip through South America, leaving New York the latter part of September. Mr. Rickard will visit the principal cities on both coasts and will make a thorough investigation of the markets and best methods of selling machinery and mechanical materials and devices.

Paul E. Ryan, formerly manager of publicity and assistant manager of foreign sales with the National-Acme Mfg. Co., Cleveland, Ohio, has taken the position of general manager of sales with the Osborn Mfg. Co. of Cleveland, manufacturer of molding machines and special machinery, foundry supplies, brushes of all kinds especially for the use of manufacturers, foundries, etc. The company, which also does wood turning and enameling, has plants in Cleveland, Milwaukee, Wis., and New Durham, N. H. Mr. Ryan's headquarters will be in the general and executive offices at Cleveland.

COMING EVENTS

September 5-11.—Foundry and machine exhibition, showing machinery, tools, equipment and supplies for the foundry and machine shop, Chicago, Ill. C. E. Hoyt, secretary, Foundry & Machine Exhibition Co., 1949 W. Madison St., Chicago, Ill.

September 7-11.—Eighth annual meeting of the American Institute of Metals, Chicago, Ill. Headquarters, La Salle Hotel. W. M. Corse, secretary, 106 Morris Ave., Buffalo, N. Y. The program prepared is an unusually strong one, and should be of interest to all connected with the non-ferrous metal industry in any way.

September 15-18.—Twenty-second annual convention of the Traveling Engineers' Association at the Hotel Sherman, Chicago, Ill. W. O. Thompson, secretary, care of New York Central Car Shops, East Buffalo, N. Y.

September 17-22.—Autumn meeting of the Iron and Steel Institute in Paris, France. Offices of secretary, 28 Victoria St., London, S. W., England.

September 20-25 (1915).—International Engineering Congress, San Francisco, Cal., in connection with the Panama-Pacific International Exposition. W. F. Durand, chairman, Foxcroft Bldg., San Francisco, Cal.

NEW BOOKS AND PAMPHLETS

Treatise on Milling and Milling Machines. 332 pages, 6 by 9 inches. Illustrated. Published by the Brown & Sharpe Mfg. Co., Providence, R. I. Price, bound in cardboard, $1; with cloth covers, $1.50.

This book has been prepared in as simple and non-technical a manner as possible, with the idea of making it of value to the beginner and practical man, but everyone interested in milling machine practice will find the field thoroughly covered in this interesting and valuable publication. The book is profusely illustrated with excellent engravings. Each section contains illustrations showing typical operations of the class treated. For example, in the chapter on gear-cutting, numerous typical examples of gear-cutting are shown, and, similarly, in the chapter on cam-cutting, every-day cam-cutting jobs are illustrated. The arrangement is unique in that the general description is given first, and this is followed by numerous illustrations showing the work being done. Each illustration is accompanied by a paragraph describing the set-up and operation of the machine for the job shown. The value of this information to the operator is apparent. Practically every class of work met with in every-day milling machine practice is shown. Some of the examples are: milling grooves and slots; surfacing brackets; face milling; cutting circular T-slots; cutting spur, worm, spiral and bevel gears; cutting cylindrical cams; milling gibs; milling flutes of twist drills, sawing flat stock; boring and drilling holes; planing, etc. It is not attempted, of course, to show how a job should be set up for commercial manufacturing, as special fixtures designed solely for certain operations are then employed. The contents by chapter heads are: Classification of Milling Machines; Essentials of a Modern Milling Machine; Erection and Care of Machine; Spiral Head—Indexing and Cutting Spirals; Attachments; Cutters; General Notes on Milling, together with Typical Milling Operations; Milling Operations—Gear Cutting; Milling Operations—Cam Cutting; Graduating and Miscellaneous Operations; Tables. The last section of the book contains a number of useful tables, among which are indexing tables for plain and differential indexing, tables of approximate angles for cutting spirals, tables of leads, index movements of spiral head for longitudinal graduating on a milling machine, etc.

NEW CATALOGUES AND CIRCULARS

Gurney - Ball Bearing Co., Jamestown, N. Y. Booklet outlining the advantages of the Gurney ball bearing. Tables give dimensions, capacities and prices of Gurney radial bearings, radio-thrust bearings and duplex bearings.

Graham Mfg. Co., Providence, R. I. Card illustrating Graham drill vises, with and without jig attachments; drill speeders; and adjustable knurl holders for turret lathe. The card is designed as a wall hanger, having twelve pertinent business maxims of general interest.

Whitman & Barnes Mfg. Co., Akron, Ohio. Circular of "W. & B. Diamond" machinists' supplies, illustrating W. & B. twist drills and reamers and their application in drilling the guard gates of the Pedro Miguel Locks, Panama Canal. W. & B. screw and drop-forged wrenches are also shown.

National Machinery Co., Tiffin, Ohio. Leaflet showing the National die-head and the work it accomplished at a demonstration, during the recent general foremen's and tool foremen's conventions in Chicago. With this tool a one-inch thread was cut on a 1⅛-inch tapered steel blank at 50 feet per minute.

C. J. Mathison, 401 Marvin St., Beloit, Wis. Circular describing a new method of disk grinding developed by Mr. Mathison, foreman grinder in the Berlin Machine Works. This is claimed to reduce the abrasive cloth disk bill more than 75 per cent as compared with the cost of the ordinary disk-grinding method.

National Tube Co., Pittsburg, Pa. Bulletin 10-C contains three articles reprinted from trade publications on steel pipe, viz., "The Relative Corrosion of Iron and Steel Pipe as found in Service," "Plain Facts about 'National' Pipe for the Plumber and Steamfitter," and "Relative Merits of Wrought Iron and Steel Pipe."

Charles H. Besly & Co., 120-B N. Clinton St., Chicago, Ill. Samples of Besly circles for use on disk grinders. The samples are mounted on 6 by 9 inch cardboard sheets, on which is printed the price-list, order number, grain and available sizes. On the back of the cards is useful information for users of disk grinders.

American Manganese Bronze Co., 99 John St., New York City. Catalogue on high-grade bronzes, showing examples of work in which Spare's manganese bronze has been used. Among these are the hull plates of the "Resolute" and "Vanitie" ships, parts of the Catskill aqueduct and Panama Canal, and other construction work.

Neil & Smith Electric Tool Co., Cincinnati, Ohio. Pamphlet on portable electrically driven tools, illustrating portable electric center grinder, drill, ball bearing grinder and screw-driver. The center grinder automatically grinds centers to the standard angle of 60 degrees, without adjustment or attention from the operator.

Doehler Die Casting Co., Court and Ninth Sts., Brooklyn, N. Y. Bulletin 105 of die-castings in white metal alloys, illustrating a variety of parts made of white metal in steel molds, which are good illustrations of the economy of using die-castings when the number of parts required warrants the cost of making the dies.

Chicago Pneumatic Tool Co., Fisher Bldg, Chicago, Ill. Bulletin 34-W descriptive of Class A-O "Giant" fuel oil engines. These engines are built in four standard strokes: 8, 10, 12 and 14 inches. The various details of construction are completely described and illustrated and a table gives general dimensions and cylinder ratings.

D. & W. Fuse Co., Providence, R. I. Circular 204, describing the latest improvements in the magnetic chucks and appurtenances made by this company. The circular shows taper attachment for flat chucks, swiveling chucks, demagnetizing switches and demagnetizers, as well as the application of magnetic chucks to some of the commonly used grinders.

Ready Tool Co., 654 Main St., Bridgeport, Conn. Pamphlet entitled "Stellite and How to Use It Successfully," setting forth the properties of "Stellite," a new cutting alloy which is non-magnetic, non-corrosive and of extreme hardness. Instructions for the use of "Stellite" and the care of "Stellite" tools are also given. This company makes "Stellite" tools for use in "Red-E" tool-holders.

Canton Foundry & Machine Co., Canton, Ohio. Booklet showing the portable floor cranes and hoists manufactured by this company. These hoists are made regularly in eight sizes varying from a machine with a height of 5 feet 8 inches and a lift of 4 feet 6 inches to one having a height of 12 feet 6 inches and a lift of 11 feet 3 inches. Certain special sizes are made with extra wide or extra narrow beds and other slight changes in dimensions.

Standard Machinery Co., Auburn, R. I. Catalogue (tenth edition) of rolling mills. 59 pages, 6 by 9 inches. The rolling mills made by this company have cut herringbone gearing and hardened and ground tool steel rolls equipped with roller bearings. The special feature claimed for them is economy in operation. Various parts of the rolling mills are illustrated, as well as different sizes of the complete machines. Special mills and applications, spoon grading and cross-rolling mills and wire-flattening mills are shown.

Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa. Booklet entitled "Ball Bearings in Machine Tools," being virtually a treatise on the subject of ball bearings, with special reference to Hess-Bright ball bearings. The book takes up the function of "Hess-Brights," early ball bearings, origin of annular type, uses of Hess-Bright ball bearings, special Hess-Bright features, mounting and closure, and applications. Halftone and line illustrations show the installation of Hess-Bright ball bearings on a variety of machine tools.

Ingersoll-Rand Co., 11 Broadway, New York City. Bulletins 3024 and 3030 entitled "Ingersoll-Rogler Valves for Air Compressing Cylinders" and "Ingersoll-Rogler Class ER-1 Power Driven Single Stage Straight Line Air Compressors," respectively. Bulletin 3024 is a treatise on the valve and 3030 is on the compressor, both being profusely illustrated and showing the details of the machine in section. It is claimed that the new line of compressors will deliver more air for the same power expenditure than other compressors on account of the distinct advantages possessed by the new type of valve. The operation of the valves is entirely independent of all valve gear or other mechanism.

Ready Tool Co., 654 Main St., Bridgeport, Conn. New catalogue 12, entitled "The Vital Factor in Cutting." Twenty pages, 6 by 9 inches. The Ready Tool Co. has given much time and thought to the vital factor in cutting—the tool—with the result that the "Red-E" tool embodies many improved features of tool design. This tool is made with a drop-forged chrome-nickel holder and a high-speed steel inserted cutter. The construction is such as to hold the tool absolutely rigid and prevent chatter. The Taylor-White process is employed for treating the high-speed steel, thus insuring uniformity of results. "Red-E" lathe, shaper, planer, roughing, threading and cutting-off tools, boring-bars and milling machine and lathe dogs are illustrated.

Moore & White Co., Philadelphia, Pa. New 1915 catalogue on friction clutches. 48 pages, 6 by 9 inches. The contents comprise description of the various parts of the clutches, information on installing, adjustment and operation of Moore & White friction clutches, horsepower rating of Moore & White clutches, prices and dimensions. The Moore & White friction clutch makes it possible for the operator to stop any piece of machinery instantly, without necessitating the shutting down of the entire line. This results in the saving of much valuable time, and in case of accident, obviates serious injury to workmen and machinery. The particular advantages claimed for the Moore & White friction clutch are: mechanical stability, starting power and simplicity.

Winter Bros. Co., Wrentham, Mass. Catalogue 9 on the complete line of taps and dies made by this company, including those made of high-speed steel. Ninety-five pages, 5 by 7 inches. The section of the catalogue devoted to the high-speed steel tools is printed on buff paper so that it can be readily distinguished. On pages 12 and 22 are illustrated taps with special styles of fluting that have not before been listed. It has been demonstrated that these styles are much better for machine use than the regular taps with four flutes, inasmuch as they greatly reduce the loss by breakage. Tables of specifications, including sizes, prices, etc., are given for machinists' hand taps, nut taps, machine screw taps, tapper taps, staybolt taps, pipe taps, etc. Adjustable round dies, solid bolt dies and spring screw threading dies are similarly treated. Among the tables of information included are: standards for wire gage in use in the U. S.; A. S. M. E. standards for machine screws, special screws, machine screw taps and special taps; tap drills for machine screw taps; and other valuable material.

TRADE NOTES

Morse Twist Drill & Machine Co., New Bedford, Mass., announces the fiftieth anniversary of the founding of the company—May 28, 1864.

Billings & Spencer Co., Hartford, Conn., received a large foreign order in July for drop-hammers which will necessitate the machine department running full time for several months.

Adolph Leitelt Iron Works, Grand Rapids, Mich., jobbers of mill, factory and machine shop supplies, are compiling a new catalogue covering these lines. The works are desirous of forming agency connections.